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The Institution is not, as a body, responsible for the facts and opinions advanced in the following Papers read, and in the Abstracts of the Conversations which occurred at the Meetings during the Session.

Annual Report, &c.

The Council of the Institute have much satisfaction in congratulating the meeting on the prosperous state of the Society. Though its establishment dates no longer than two years ago, yet, during that brief period, it may be safely stated that material progress has been made, and light thrown upon various branches of mining which were previously either not at all or very imperfectly illustrated, while such current subjects of interest as are connected with the objects of the Society, whether arising within the pale of the profession, or from extraneous sources, have, it may fairly be said, met with equal consideration, and have been placed, it is hoped, on their right basis by the patient investigation bestowed upon them.

The Council cannot, perhaps, relate the progress of the Institute in a more effective shape, nor better shew its practically useful tendency, than by a notice of the papers which have been read and discussed at the several meetings since the commencement of its career:—

1. After the excellent Inaugural Address of the President, the earliest in the order of papers read was one by Mr. James A. Longridge, on the Steam Jet as a Motive Power for purposes of Ventilation.

2. An account of elaborate experiments on the relative value of the Furnace and Steam Jet in the Ventilation of Coal Mines, by Nicholas Wood, Esq., President of the Society.

3. Account of Experiments on the same subject by Mr. William Armstrong.

4. Notices of similar Experiments by Messrs. Wm. Barkus, T. John Taylor, and Matthew B. Robson.

5. On the Ventilation and Gases of Mines and the working of Pillars, by Mr. William Barkus.

6. On the Subsistence of Fire Damp in a state of high tension in Sitû, by T. John Taylor, Esq.

7. On Safety Lamps for lighting Coal Mines, by Nicholas Wood, Esq., with Appendix of Experiments with various Safety Lamps, by T. John Taylor, Esq., and others.

8. On Safety Lamps, with an account of a proposed improved Lamp, the main object of which is to obtain a more brilliant light than that yielded by the Davy Lamp, by Mr. T. Y. Hall.

9. Improvements in Colliery Workings, and observations on Safety Lamps, by Mr. T. Y. Hall.

10. Observations on the greater facility of Ventilating Dip than Rise Workings, by Mr. G. C. Greenwell.

11. On Choke Damp, and the means of counteracting its effects, by Mr. James A. Longridge.

12. A communication on the subject of Safety Lamps, from Mr. Herbert Mackworth, Inspector of Mines.

13. On Improvements in Boring for Minerals, Wells, and Shafts, by Mr. Mackworth.

14. On Waring's Coal Cutting Machine, by Mr. Mackworth.

15. On Water as a Ventilating Power, by Mr. Mackworth.

16. On Penetrating Dangerous Gases, by Mr. T. Y. Hall.

17. An elaborate paper on the Extent and Probable Duration of the Northern Coal Field, with remarks upon the Coal Trade, by Mr. T. Y. Hall.

18. On Mines and Mining in the North Staffordshire Coal Field, by Mr. John Hedley.

19. Notes on the Coal Field of East Somerset, by Mr. G. C. Greenwell.

The very minute manner in which the *vexata quæstio* of the steam jet has been investigated in the first of the foregoing series of papers may be cited as an example of what may be expected to constitute the future course of the Society on similar occasions, where a suggestion is made or an improvement proposed, which is based upon such apparently sound grounds, as entitled it at all events to investigation. In a similar manner will be hereafter tested the real value of propositions made for the improvement of Mining Science, a test beyond the reach of individuals, and which, it is obvious, could not be applied except through the medium of a united and competent body.

The excellent paper of Mr. Hedley, together with various other communications received from mining districts at a distance, evince in a marked degree the advantages accruing from the establishment of the Institute, since the valuable information thus furnished, either could not

be obtained, or must have been acquired by individuals at material inconvenience and probably expense.

To the foregoing outline of the proceedings of the Society may be added the equally interesting discussions which have taken place on the several papers, and the exhibition of maps and models.

Such is a brief statement of the work done during the two years of the existence of the North of England Mining Institute; and the Council are gratified to say that the extension of the Society is in a ratio not incommensurate with the activity displayed by its individual members. The increase of members during the past year has been from 114 to 143, and there is every reason to believe that an augmentation may be expected for some time to continue, as the Institute becomes more generally known, and its publications more extensively consulted by scientific and practical men.

The report presented by the gentlemen who have taken upon themselves the duties of the Finance Committee, affords a not unpleasing corroboration of the progress making, and the liberality with which pecuniary support is afforded to the Institute and its objects. To this essential element of success the attention of the Council will continue to be directed, in the hope that the present friends of the Society will continue their support, and that others, incited by their example, will come forward for a similar purpose, not merely on particular, but also on public grounds. The much agitated question of security to the miner is obviously identified with that of mining improvement.

The Council may be permitted to refer with feelings of satisfaction to the general arrangement for holding meetings, for a library, and for the safe custody of plans, models, and apparatus, which have been made under the inspection and by the care of the general Committee of the Coal Trade, as a proof of the high sense which the trade entertain of the importance of the Institute, and their wish to contribute by every means in their power to its prosperity and usefulness. The Council cannot view what has been done with any other feelings than those of unmixed pleasure, and they congratulate the meeting accordingly upon the convenient apartments in which they now find themselves located.

It becomes, of course, one of the primary views of the Institution, to collect gradually, a library of such British and foreign publications as are connected, either immediately or indirectly with its objects. In this some progress has been made. The Society has been favoured with statistical accounts of the mines of Belgium and France. It has also the honor to comprise amongst its members, gentlemen resident abroad, dis-

tinguished for engineering and scientific attainments, and from them by a reciprocal interchange of publications gradual additions to the library of the Institute may be expected to accrue.

The Society's transactions also exhibit the pleasing fact of contributions of books due to the liberality of individual members, upon the occasional recurrence of which the Council cannot err in relying. It may be proper to mention, that in furtherance of these views, copies of the printed transactions of this Institution have already been exchanged for publications of the same nature from abroad, kindly presented by friends of science connected with mining pursuits, and that such reciprocal interchange may be expected to continue.

It has been deemed by some that these advantages might be still further multiplied and secured by some junction of this Institution with Societies elsewhere, pursuing the same or similar objects. This, however, will require grave consideration. To an Institute bearing upon objects less of pure science, than of great, practical, national, and commercial importance, independence of action is the first requisite, without which every other may become worse than useless; and the Council cannot but conclude that, however advisable and useful may be intercourse between bodies pursuing kindred ends, junctions like those alluded to cannot be too cautiously considered in all their consequences, nor too narrowly looked to in the tendencies which they may produce. In saying this, the Council must not be understood as undervaluing the great and undoubted services effected by the communication of papers and other transactions of which their own minutes contain some pleasing evidence, nor the vast utility of the transmission of plans and models to and from Societies having similar pursuits. Such intercourse cannot (they think) be too much encouraged.

It is thus advantageous however, because whilst rendering the spread of knowledge very compendious and regular, it does not interfere with that independence upon which the ultimate value of institutions depend.

While upon this subject the Council cannot forbear noticing with satisfaction, that a general meeting of representatives from the several coal mining districts of the kingdom has been held in London during the current year. From this meeting, which is the first of the kind that has been hitherto assembled, a favourable augury may be drawn of the future results of joint efforts in the same good cause. Reflecting upon the vast importance of the coal mining interest of Great Britain, it appears not too much to expect that a similar meeting may be held annually, for the purpose of maintaining a healthy condition of that interest, and

especially with a view to the safety and welfare of the persons employed in working and conducting the mines.

Amongst the changes of the past year, the Council have to report the resignation of the Secretary of the Institute, Mr. Edward Sinclair, whose future residence in Monmouthshire, will deprive the Society of his valuable services. In his place Mr. Thomas Doubleday, who is also Secretary to the Trade at large, has been appointed, and it is not doubted that the well known and remarkable literary talent of that gentleman will prove of service to the Institute.

The Council cannot conclude their report without venturing the expression of their confident hope that the progress already made may only act as a stimulus to the zeal of members, and that communications bearing upon the objects of the Society may not only be expected to flow in from residents in the northern coal districts, but that the Society may look to be favoured with papers on points connected with mining engineering generally, as practised in other districts and under the varied circumstances of different and distant localities. Upon such communications the utility of this Society must greatly depend; and the exertions and opportunities of the various members must be looked to as the means of making it known generally that such is the intent and scope of the Institution.

Finance Committee's Report.

31st JULY, 1854.

Gentlemen,

At the close of the second year of the Society's existence, the Finance Committee have much pleasure in announcing that it is established in proper rooms, worthy of the importance of its objects, and conveniently situated for access to its members.

We understand that this has been chiefly owing to the liberality of the Coal Trade Committee of Newcastle, to whom we suppose due allusion will be made in the President's address, we therefore proceed to notice the financial position of the Society.

The cash outlay during the twelve months just ended (as per Treasurer's accounts), amounts to the sum of £220 9s. 3d., and the income from various sources (inclusive of a balance of £151 11s. 6d. from last year), to the sum of £478 15s. leaving an amount in hand of £258 5s. 9d.

The liabilities, consisting of the Secretary's salary and two small items for advertizing, amount to the sum of £26 13s., whilst the assets, consisting of the balance in hand, uncollected subscriptions, papers unsold, and a donation from W. B. Wrightson, Esq., are of the value of £433 1s. 3d., leaving a balance available for the future expenses of the Society of £406 8s. 2d.

The position of the Society is a good one, and will, we think, with care and economy, enable it fully to follow out the objects for which it was established, without urging its publications before the public, and thus lowering their value to too great an extent, with the view of realizing funds.

We should, at the same time, recommend the sum of one hundred pounds to be laid out in the purchase of a good and well selected collec-

tion of scientific works relating to mining, and with this view would suggest that a proper minute book be kept, in which the members might recommend to the Society the purchase of books, from time to time, the final selection being left to the discretion of the Council of the Society.

We would also suggest, with the view of greater economy, the regular publication of the Society's papers upon fixed days in each month, and would also urge that these publications might be made the vehicle of communication to the members all over the kingdom, of the times of their next meetings, as well as other information requisite in the progress of the Society.

We are of opinion this would save a considerable amount in postage and circulars, in proof of which we would refer to the large amounts paid for these items in the Treasurer's accounts of the past year.

We would also urge upon the Council the making of the publications of the Society as profitable as possible, by permitting advertisements on the covers of the monthly papers. We are induced to this course by observing that other scientific societies adopt this plan, and we see no reason why the Mining Institution, which is more closely allied with commercial pursuits, should not follow their example.

In furtherance of the objects of the Society, we would also recommend constant attendance either by the Secretary or some one else, on stated days, at the rooms of the Institute, so as members from distant parts may enjoy every facility of communicating with the Council and members with whom they may wish whilst sojourning in the district.

With these suggestions, and leaving to the Council and members the proper and efficient mode of carrying out the objects of the Society.

We are, Gentlemen,

Your obedient Servants,

(Signed,) CHARLES CARR,
WM. BARKUS,
P. S. REID,
E. F. BOYD, Treasurer.

THE TREASURER IN ACCOUNT WITH THE NORTH OF ENGLAND MINING INSTITUTION.

1854.	Dr.	£	s.	d.
July 31.—	To Balance in hand from 1st Year..	151	11	6
	" Subscriptions from 111 Members to this date	233	2	0
	" Amounts received from the following Collieries, viz :—			
	Crow Trees and Heugh Hall	4	4	0
	South Kelloe and Coxhoe	4	4	0
	Byers Green Colliery	2	2	0
	Hunwick Colliery.....	2	2	0
	Black Boy Colliery	4	4	0
	Leasingthorne Colliery.....	2	2	0
	Westerton Colliery	2	2	0
	Barrington Colliery	3	3	0
	Trimdon Colliery	4	4	0
	Thornley Colliery..... ...	6	6	0
	Lambton Collieries	10	10	0
	North Hetton Collieries	10	10	0
	Haswell Collieries	8	8	0
	Seghill Collieries	5	0	0
	Cowpen Colliery	5	0	0
	Merrington Colliery.....	2	12	6
	Whitworth Colliery.....	2	12	6
	Stella Coal Company	2	2	0
	To Amount received from Sale of Publications	12	13	6
		478	15	0

1854.	Cr.	£	s.	d.
July 31.—	By Amount paid for Reporting to date	8	18	10
	" Cash paid for Postage at various times	13	11	7
	" Cash paid for attendance at the Literary and Philosophical Society's Lecture Rooms	1	7	6
	" Cash paid for Printing Society's Papers.....	136	2	10
	" Cash paid for Circulars and Advertising	33	6	8
	" Cash paid Secretary for Salary, 1st Year	25	0	0
	" Cash paid for Carriage at various times	2	1	10
	By Balance in hand	258	5	9
		478	15	0

GENERAL ANNUAL STATEMENT, 1st AUGUST, 1854.

1854.	Liabilities.	£	s.	d.
August 1.—	To Secretary, One Year's Salary..	25	0	0
	" Proprietors of the Mining Journal	1	1	0
	" Proprietors of the Newcastle Guardian.....	0	12	0
	To Balance in favour of Society	406	8	3
		433	1	3

1854.	Assets.	£	s.	d.
August 1.—	By Amount of Cash in hand	258	5	9
	" Members' Subscriptions Uncollected	37	16	0
	" Colliery Subscriptions Unpaid to date	50	8	0
	" Amount allowed for Publications unsold	84	11	6
	" Donation from W. B. Wrightson, Esq.	2	0	0
		433	1	3

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115 Smith, J., Thornley Colliery, Durham.
116 Smith, F., Bridgewater Canal Office, Manchester.
117 Seymour, M., South Wingate, Ferry Hill.
118 Stephenson, R., M.P., 24, George Street, Westminster.
119 Sanderson, R. B., jun., West Jesmond, Newcastle.
120 Sopwith, T., Allenheads, Haydon Bridge.
121 Stott, R., Ferry Hill.
122 Stenson, W., Whitwick Colliery, Ashby-de-la-Zouch.
123 Stenson, W., jun., Whitwick Colliery, Ashby-de-la-Zouch.
124 Sinclair, E., Tredegar, Newport, Monmouthshire.
125 Taylor, H., Earsdon, Northumberland.
126 Taylor, T. J., Earsdon, Northumberland.
127 Taylor, J., Haswell Colliery, Durham.
128 Telford, W., Cramlington, Newcastle.
129 Todd, H. W., Mickley Colliery, Newcastle.
130 Thomas, W., Bogilt, Holywell, Flintshire.
131 Thompson, T. C., Kirkhouse, Brampton, Cumberland.
132 Wood, N., Hetton Hall, Fence Houses.
133 Wood, C. L., Blackboy Colliery, Bishop Auckland.
134 Wood, W., Trimdon, Trimdon Colliery, Hartlepool.
135 Wales, J., Hetton Colliery, Fence Houses.
136 Watson, W., High Bridge, Newcastle.
137 Wilson, J. B., Haydock Rope Works, near Warrington, Lancashire.
138 Woodhouse, J. T., Overseal, Ashby-de-la-Zouch.
139 Walker, T. jun., High Street, Maryport.
140 Watney, A., Gwendraeth Iron Works, Carmarthenshire.
141 Witham, Rev. Thos., Lartington Hall, Barnard Castle.

Rules.

1.—That the Members of this Society shall consist of Ordinary Members, Life Members, and Honorary Members.

2.—That the Annual Subscription of each Ordinary Member shall be £2 2s. 0d. payable in advance, and that the same shall be considered as due and payable on the first Saturday of August in each year.

3.—That all Persons who shall at one time make a Donation of £20 or upwards, shall be Life Members.

4.—Honorary Members shall be persons who shall have distinguished themselves by their Literary or Scientific attainments, or made important communications to the Society.

5.—That a General Meeting of the Society shall be held on the first Friday of every month, at two o'clock p.m., and the General Meeting in the month of August shall be the Annual Meeting, at which a report of the proceedings, and an abstract of the accounts of the previous year shall be presented by the Council. A Special Meeting of the Society may be called whenever the Council shall think fit, and also on a requisition to the Council signed by ten or more Members.

6.—No alteration shall be made in any of the Laws, Rules, or Regulations of the Society, except at the Annual General Meeting, or at a Special Meeting; and the particulars of every alteration to be then proposed shall be announced at a previous General Meeting, and inserted in its minutes, and shall be exhibited in the Society's meeting-room, fourteen days previously to such General Annual or Special Meeting.

7.—Every question which shall come before any Meeting of the Society, shall be decided by the votes of the majority of the Ordinary and Life Members then present and voting.

8.—Persons desirous of being admitted into the Society as Ordinary or Life Members, shall be proposed by three Ordinary or Life Mem-

bers, or both, at a General Meeting. The proposition shall be in writing, and signed by the proposers, and shall state the name and residence of the individual proposed, whose election shall be ballotted for at the next following General Meeting, and during the interval, notice of the proposition shall be exhibited in the Society's room. Every person proposed as an Honorary Member must be recommended by at least five Members of the Society, and elected by ballot at the General Meeting next succeeding. A majority of votes shall determine every election.

9.—The Officers of the Society shall consist of a President, four Vice-Presidents, and twelve Members who shall constitute a Council for the direction and management of the affairs of the Society; and of a Treasurer, and a Secretary; all of whom shall be elected at the Annual Meeting, and shall be re-eligible. Lists containing the names of all the persons eligible having been sent by the Secretary to the respective Members, at least a month previously to the Annual Meeting;—the election shall take place by written lists, to be delivered by each voter in person to the Chairman, who shall appoint scrutineers of the lists; and the scrutiny shall commence on the conclusion of the other business of the meeting. At meetings of the Council, five shall be a quorum, and the record of the Council's proceedings shall be at all times open to the inspection of the members of the Society.

10.—The Funds of the Society shall be deposited in the hands of the Treasurer, and shall be disbursed by him, according to the direction of the Council.

11.—The Council shall have power to decide on the propriety of communicating to the Society, any papers which may be received, and they shall be at liberty when they think it desirable to do so, to direct that any paper read before the Society shall be printed. Intimation shall be given at the close of each General Meeting of the subject of the paper or papers to be read, and of the questions for discussion at the next meeting, and notice thereof shall be affixed in the Society's room ten days previously. The reading of papers shall not be delayed beyond 3 o'clock, and if the election of members or other business should not be sooner dispatched, the President may adjourn such business until after the discussion of the subject for the day.

NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS.

PROCEEDINGS

OF THE

NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS,

AT THE

GENERAL MEETING,

ON THURSDAY, NOVEMBER 3RD, 1853.

Newcastle-upon-Tyne:
PRINTED BY ANDREW REID, GUIDE OFFICE, 117, PILGRIM STREET.

1853.

NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS.

GENERAL MEETING, HELD IN THE LECTURE ROOM, NEWCASTLE-UPON-TYNE, NOVEMBER 3, 1853.

NICHOLAS WOOD, ESQ., PRESIDENT OF THE INSTITUTE, IN THE CHAIR.

The minutes of the last General Meeting having been read by the Secretary,

The PRESIDENT stated that the Committee which had been appointed to ascertain "where and on what terms a suitable room for the meetings of the Institute, with convenient offices adjoining, where the library of the Institute could be kept, and members have access to it at any time," could be procured, had met that morning and agreed upon a report, which would be read by the Secretary. The Committee had inspected Mr. Leadbitter's house, in Westgate Street, and thought it would be a suitable place for the purposes required, if it could be obtained at a moderate rent. They were also of opinion that it would be desirable, if possible, to secure the co-operation of the Coal Trade Committee, which might hold their meetings there also, diminishing in some degree the expense to the Institute. There was, no doubt, great need of a suitable building for the Institute, for at present, although they had the use of the Lecture Room of the Literary and Philosophical Society, for which they were indebted to the members of that Society, yet though a public Institute, they, it might be said, had not any location, nor had they any room to deposit papers or books, or any place to transact business. He suggested that the Committee should be empowered to treat with Dr. Charlton, who had the letting of the house he had referred to, and

ascertain from him the amount of rent, and whether he would undertake to alter it and fit it up for the occupancy of the Institute.

The Report having been read, the motion, recommended by the President, was put and carried unanimously.

The PRESIDENT exhibited a neatly-bound volume of the Proceedings of the Institute during the past year, which was adopted as the form of publication of the Society's proceedings.

The PRESIDENT then referred to the papers standing for discussion. Mr. Taylor's paper, read at the last meeting, had only been a few days out of the printers' hands, and therefore had not been circulated among the whole of the members. It would, consequently, be inconvenient to take the discussion upon it at this meeting, but they might come prepared to do so at the meeting of next month. The subject of the Steam Jet and Furnace Ventilation had, he thought, been exhausted, and the discussion upon them might, therefore, be considered at an end. His own paper on Safety Lamps, giving an account of the experiments he had made upon various Lamps, had not been printed yet; Mr. Hall had read a paper on Safety Lamps, which had since been printed. As this subject was still under investigation, and they having been promised some further information upon it, he thought it would be better to defer the discussion at present. He next referred to the necessity of the members of the Institute giving timely notice of their intention to furnish papers to be read at the monthly meetings; it was desirable that they should not have to wait until the monthly meeting before the Council knew what papers were to be produced; and he referred to the general rules on the subject. He was sorry they were that day disappointed of a paper by Mr. Mackworth, who had promised to prepare one bearing upon Boring for Coal in Belgium; it had been sent to be read last month, but there being no meeting, Mr. Mackworth got it back again for revision, and had not returned it; they might, however, expect it at the next meeting. The same gentleman had laid before the Institute a paper containing an abstract from the Transactions of the Royal Academy of Belgium, relative to the proposal of that Government to offer a prize of 2,000 francs to the author of a practical, commodious, and safe method by which a person might be enabled to penetrate without delay to great distances, to abide there some time, inform himself as to the state of, and act freely in underground excavations, filled with dangerous gases, and especially in explosions of fire-damp. The Royal Academy had appointed a Committee to draw up a report upon the subject, and that report was presented to the Minister of Public Works. The document had been

translated, and the Secretary would read it. The Academy, he might state, had offered their gold medal in addition to the above prize. Communications would be received from any country, but the term of competition was fixed for December 31st, 1853, beyond which day no essays would be received.

The SECRETARY then read the following document:—

ROYAL ACADEMY OF BELGIUM.

(Extract from Vol. XIX., No. 6, of the Bulletins.)

The Minister of Public Works having consulted the Members of the Academy upon the utility of appointing a Special Commission to improve the means of Safety on account of Accidents vitiating the Air in the Workings, the members appointed Messrs. De Vaux, Stas, and De Stemptinne, to prepare a Report on this subject for him.

M. De Vaux, in the name of the Commissioners, read the Report as follows:—

Your Commissioners have studied, with much interest, the question raised by the Minister of Public Works, in the despatch of 17th April last, No. 2271.

You cannot fail to sympathise with this proposition of the Minister, which is so benevolent and philanthrophic; the effect produced by it will be to aid the working classes, to stimulate the genius of invention, and to increase the means of safety.

The accident which happened on 6th March last, in the coal district of Langterm Ferrand, at Elonges, has aroused attention to this subject, and has created a deep interest in the management of mines. On that occasion, the utter inability of a number of workmen to reach the victims of this catastrophe was painfully exhibited. The heavy falls in the principal rolleyway certainly opposed an insurmountable obstacle to the speedy restoration of the circulation of air in this way; but, in all probability it was beyond these falls, where the miners would be found, and it was the universal opinion, that the main return air course remained open, and in good condition, throughout its whole extent, about 600 metres* from the entrance to the face of the workings. Now, this gallery, through which one would gladly have proceeded towards the face of the workings, were

* A metre is 40 inches.

it only to relieve the anxiety felt for the fate of 63 fellow-men, this gallery, being filled with deleterious gas, was inaccessible, and no one could have proceeded a few metres along it, without being seized with asphyxia. A few days after, on the 12th March, the coal district Maritage, at Seraing, in the Province of Liege, became in its turn the scene of a catastrophe, whereby seven workmen lost their lives, under circumstances still more deplorable than those at Langterm Ferrand, inasmuch as it was impossible to penetrate quickly into the excavations filled with deleterious gasses. The water of some old mines burst into the workings of the coal mine of Maritage; the quantity, according to all appearance, was not so great as to carry away the workmen with the current, but independent of the dangerous gas which came into the mine with the water, the level of the water rose so high as to stop the circulation of the air, and from that moment, all who had attempted to escape by running and raising themselves above the level of the water, became in imminent danger of asphyxia. Now, in this case, the workmen were neither exposed to fire, nor yet to the terrible commotion which usually accompanies an explosion of fire-damp, and there were scarcely 100 metres to traverse in the air-course before they would have been rescued.

If we confine ourselves to these occurences it is not because other examples are wanting; cases of asphyxia are unhappily only too frequent in mines, especially after fire or bursts of water. But we would remark, that it is not in mines only that the lives of workmen are affected by deleterious emanations; the same danger frequently occurs in underground excavations of little depth, which are daily used in our buildings; in certain wells, common sewers, shallow ditches, cisterns, &c., and it will be easily seen, that the question proposed should embrace all these different cases. On the other hand, various methods have been proposed, or tried, to prevent these casualties, and competitors ought to make themselves well acquainted with all that has been done or published on this subject—ventilators, respiratory apparatus, air pumps, the apparatus of Paulin for conflagrations, &c.

It would be, perhaps, useful to them, if we were to give publicity to the different addresses, which could be procured from the office of Home Affairs upon analogous subjects, and among others, to a report addressed to the Home Minister, July 14th, 1848, by a Special Committee composed of the Inspector General of Health, De Hemptime, Member of the Academy, and De Vaux, Inspector General of Mines.

The Competitors should acquire immediately all the knowledge which will spring up from the appeal made to inventors, the managers of mines

should do their utmost to render practical the use of respiratory apparatus and to obtain mechanical ventilators which can be easily transported to where required, and the working of which, combined with the use of large pipes or tubes, may speedily purify the air in an excavation, the atmosphere of which is vitiated.

With regard to the terms in which the question is put by the Minister of Public Works, your Committee have nothing to alter, viz. :—

"That a prize will be given to reward the author of a practical proceeding of a method, commodious and safe, which will permit a man to penetrate without delay to great distances, to abide there some time, to obtain a knowledge of the circumstances, and act freely in underground excavations filled with dangerous gases."

We consider that we should insist on one point, viz., that the individuals appointed to judge of the merits of the plans proposed, should know enough to be on their guard against the abuse of theoretical considerations; that is to say, that the prize ought only to be given when the essays, following and concluding, have clearly proved the infallibility, and also the facility of employing the plan proposed in the different cases which may be met with.

We conclude by remarking that, considering the difficulty of the question, and the time that the essays must require, the term for this competition may be fixed for December 31st, 1853.

The Report has been received and adopted; it shall be communicated to the Minister of Public Works, informing him, at the same time, that the Academy will add its golden medal to the prize of 2,000 francs already offered by the Royal Mandate.

No contributions will be received after December 31st, 1853.

The President said—It very often happened when explosions took place, that the parties entering the workings could get to within a short distance of where the men were, but were unable to reach them; so that if anything could be contrived which would enable a person to push on through the foul air, it would be extremely desirable. No object was perhaps of more importance in mining than the recovery of the men who happened to be in a mine when explosion occurred. He believed three-fourths of the lives were lost in this way, not from the explosion itself but from the deleterious air afterwards—commonly called the after-damp. [Mr. Easton—Nine-tenths.] A very large proportion indeed were lost

in that manner. He did not think this subject had been as much attended to as it deserved: but he trusted more attention would be paid to it in future.

Mr. Easton remarked that one full inspiration of carbonic acid gas was sufficient at all times to produce asphyxia.

Mr. Boyd said he was just going to make the same remark. In one case he had made application to a medical man, and his answer was: "where a man is once prostrated with it, all the power on earth would be of no avail."

Mr. Barkus said there must be some mistake as to the properties of the gas they had to deal with, after an explosion. That part of the mine where an explosion occurs, will be filled with about 9-10ths of atmospheric air, and 1-10th of carburetted hydrogen. The former

composed of 77 parts nitrogen.
23 „ oxygen.
100

And the latter of equal parts of carbonic acid gas and hydrogen,

or 69·3 of nitrogen.
20·7 of oxygen.
5 of carbonic acid.
5 of hydrogen.
100

After an explosion, the oxygen and hydrogen unite and form water, leaving the nitrogen and carbonic acid (which is usually termed after-damp), to be removed mechanically by the current of pure atmospheric air when directed into the mine. Having been induced to descend Springwell Pit, on the 6th of December, 1837, after an explosion, in order to assist in getting to the men lost on that occasion, accompanied by Messrs. Southern, Sinclair, and my son, we proceeded beyond where the air had been confined to (in consequence of the lamps burning so bright and clear), in the direction of that part of the mine where the people had been working; however, after proceeding a short distance, the first-named two gentlemen complained of unpleasant sensations, and almost immediately became powerless, inasmuch, that they had to be carried out into the air-course; during this time, the lamps continued to burn the same as when in a pure atmosphere, without showing the usual symptoms of the presence of carbonic acid gas. A peculiar atmosphere must have been formed here to support flame, but destructive to animal life.

Mr. SINCLAIR said they had known instances where persons had been got out alive after breathing the deleterious air of the mine, after an explosion, and completely recovered.

Mr. BOYD—That depends upon the state of the air at the time.

Mr. SINCLAIR—Yes; but it is clear they lived some time in the impure atmosphere, and that shewed the importance of the Belgian inquiry as to the possibility of introducing some method of speedily relieving them.

Mr. BOYD—There was no doubt a great many lives were destroyed by the after-damp. This was the case some time ago in a colliery with which he was connected. One man was saved in a district further in than where the great majority of the bodies were found. He was himself instrumental, under God's mercy, of saving that man, but it was only by pushing over all the dead bodies, to the sixth bord, where the man was lying. He had not imbibed so much of the carbonic acid gas as the others, and he was still breathing, though insensible. He was brought out, and got well, but was about twelve weeks before he completely recovered.

The PRESIDENT said he thought it would be wrong to allow the impression to go abroad that life was destroyed in an instant; it was only after a man had breathed the deleterious atmosphere for some time that life became extinct. They had known men who must have been some time in the deleterious gas, got out and restored. There was always some portion of atmospheric air left after the explosion; it was seldom or never entirely destroyed, and the parties under such circumstances obtained a little respirable air which had been left after the explosion. They had known persons to all appearance dead brought round by judicious treatment: and he did not, therefore, think they ought for one moment to sanction the conclusion, that because a person was immersed in air which apparently was incapable of sustaining animal life, that no means should be employed to reach him, or that life was destroyed immediately; there was sufficient time, if a suitable invention were at hand to enable a person to penetrate the deleterious atmosphere with safety, to succeed in reaching the men, and probably saving many lives.

Mr. EASTON—There are two deleterious gases produced in the mine, carbonic acid gas and nitrogen.

The PRESIDENT—It is what remains after an explosion that destroys life, what is called choke-damp.

Mr. EASTON—The effect of both gases is the same; both produce asphyxia.

The PRESIDENT—Whatever the effect may be, it is well known that the men live some time in the vitiated atmosphere. They are seldom struck down at once, but the effect upon them gradually increases, and it goes off again on their coming into the pure air at the bottom of the shaft.

Mr. EASTON—There is a partial decomposition of the air produced by the explosion; the oxygen becomes consumed, and what is left is incapable of sustaining animal life. What is required is some means of restoring the atmosphere quickly to its former state, or providing against the effect of it while immersed in it.

Mr. LONGRIDGE suggested the use of a helmet similar to those used by divers under water, who remained immersed for considerable periods without feeling the least degree of inconvenience. He thought such an apparatus might be adapted so as to be applicable in coal mines, when it became necessary to penetrate a deleterious atmosphere.

Mr. DUNN said the principle had been carried out in the diving bell, and Mr. Hutchinson in his evidence before the Parliamentary Committee of 1849, had suggested its application in mines.

Mr. GREENWELL—The effects produced by carbonic acid gas and nitrogen are quite different. The effect of nitrogen is like that of drowning; carbonic acid gas acts in the way of direct poison, but the other merely acts by deprivation of oxygen. If a person may be recovered from death by drowning, so may he be restored from the effect of nitrogen, provided it has not gone too far.

The PRESIDENT—As was remarked by one gentleman, the whole of the air in the mine was destroyed by the explosion; there was still remaining a portion, more or less, of atmospheric air mixed with the gases; and though the air in that state might not be capable of sustaining amimal life for any long period of time, it might do so till relief was obtained. He thought it quite practicable that contrivances might be struck out which would enable a person to enter the impure atmosphere of a mine with safety after an explosion.

Mr. BARKUS, taking up the elastic tube of the gas pipe which lay upon the table, applied the end of it to his mouth, and said he thought some handy apparatus of that kind, which a man could seize upon and run along the bords with, applying it to his mouth when necessary, might be easily contrived, the man carrying one end and the other being attached to an air-pump.

The PRESIDENT said, he thought a man might carry with him a supply of extremely condensed oxygen, to be made available when necessary.

He considered it desirable that the attention of the public generally should be called to the subject, which was of a medical as well as of a mechanical nature, and for that purpose he suggested that the proceedings of this meeting in reference thereto should be published in the local newspapers, to draw the attention of the scientific gentlemen of the district to the subject.

Mr. EASTON, with reference to the remarks of Mr. Greenwell, said, that carbonic acid gas when inhaled by a person, produced spasm of the epiglotis and prevented inspiration. Nitrogen did not do so, but it acted upon the lungs. Both, however, produced asphyxia. Nitrogen did not destroy life immediately, but gradually; the other, carbonic acid gas, almost instantaneously.

Mr. GREENWELL—I differ with you.

Mr. BOYD—In the case to which he had alluded, several of the men were found not quite dead; they were not absolutely dead, though they were so to all appearance; but they all died on being carried out into the air, except the man who was found furthest in, and who only recovered after twelve weeks.

Mr. EASTON—The men all knew the effect of the deleterious gases, and the practice of the old men in the colliery trade was a very sensible one; although they acted without knowing the reason why. The first operation was to place the man's head in a hole in the ground, from which a sod or turf had been cut. If he was to breathe the pure atmosphere at once, in the weak state the lungs are in after being some time in the deleterious atmosphere of the mine, it would probably destroy life instead of saving it. The air in passing through the soil became somewhat changed, so that it was less injurious under the circumstances.

After some further conversation, it was arranged that Mr. Sinclair should receive any essays on the subject of the Belgian inquiry from the members of this Institute and gentlemen of the district who might be disposed to investigate the matter, and forward them to the Belgian Government Commissioners.

Mr. T. Y. HALL submitted several beautiful drawings of his Improved Safety Lamp, which were inspected by the President and the members present.

The meeting then adjourned.

NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS.

GENERAL MEETING, HELD IN THE LECTURE ROOM OF THE LITERARY AND PHILOSOPHICAL SOCIETY, NEWCASTLE-UPON-TYNE, DECEMBER 1, 1853,

NICHOLAS WOOD, ESQ., PRESIDENT OF THE INSTITUTE, IN THE CHAIR

THE minutes of the last General Meeting having been read by the Secretary,

The PRESIDENT stated that since the last meeting the Committee appointed to ascertain "where and on what terms a suitable room for the meetings of the Institute, with convenient offices adjoining, where the Library of the Institute could be kept, and members have access to it at any time," could be procured, had had a meeting with Dr. Charlton and Mr. Leadbitter, and had drawn up a report upon the subject which the Secretary would read.

The report was then read by the Secretary.

A plan of the building was also exhibited, and the proposed alterations, in order to adapt it for the use of the Institute were explained by the President, after which it was unanimously resolved, that the Committee do confer with the Committee of the Coal Trade in order to ascertain whether they would join the Institute in the occupancy of the building.

The PRESIDENT said, the regular course of proceeding would be to take the discussion upon Mr. Taylor's paper, on "the Existence of the Fire Damp of Coal Mines, in a state of high tension in sitû," and on "Safety Lamps," on which subject a paper by Mr. Hall, was read, at a previous meeting. He was happy to say that they had three papers to read that day,

but still he thought it best to follow the rules of the Society; and first to take the discussion upon papers which had been read at previous meetings. They would not, therefore, take any discussion upon the papers that would be read that day, but any explanation might be given upon any point which required explanation. As the discussion upon Mr. Taylor's paper came first before the meeting, he should now be happy to hear any remarks from any gentleman upon the subject. He had been told that Mr. Easton had something connected with it to state to the meeting, and he should be happy to hear him.

Mr. Easton said he merely had to observe that about a week ago there was an erruption of gas in Hebburn Pit, and as Mr. Taylor's paper was very much in point, he had simply taken notes of the facts, and reported them to that gentleman, with a pencil sketch of the part where the erruption occurred. It was a matter of very little consequence, he considered, but the circumstances connected with it were rather unusual.

The President—Perhaps you could favour us with the sketch, and a brief description of it, which we might embody in the proceedings of the Institute.

Mr. Easton said the drifts were three in number, and two of them had reached the dyke, and proned the fissure of it. The third one was going under the top coal, and had reached within about two feet of the Dyke; an eruption of gas came through the top coal, and the most remarkable feature connected with it, was the circularity of the hole, shewing a very singular operation of the gas. The hole was as perfect a circle as could be; it was almost 2½ feet in diameter, and 3 feet in depth. The gas accumulated for a few minutes, but the men were not frightened by it, they were working with lamps, and scarcely noticed the place foul. This was the first instance he had met with of a blower producing a circular aperture by the force of its evolution. The coal was not ragged, but it appeared just as if the hole had been bored.

The President—Was there any partings around it?

Mr. Easton—No! It was a hole right into the fissure of the dyke. I have not in my experience met with anything like it.

The President—Then we are to understand there was about two feet of coal forced out of the solid mass.

Mr. Easton—Yes; out of the top coal, which was about 2 feet 8 inches thick, and within two feet of the dyke. The gas blew the coal out in a circular form.

Mr. Hall—There was no doubt Mr. Taylor's paper was a very able one, and one very much wanted by the Society.

MR. TAYLOR (to Mr. Hall,)—Have you any instance to give?

MR. REID—I have a queston to put to Mr. Taylor, as regards the length of time Percy Main Pit was filled with water? No period of time is mentioned in his paper.

MR. TAYLOR—I would give you the information to-day, but I find I cannot without referring to the original papers. I believe it was from November to about February or March.*

Mr. REID—I think that has a very important bearing upon the subject, inasmuch as the mine being filled with water to a certain height, as soon as the water began to be lowered, a certain quantity of gas came off. The mine was long filled with water, and it would appear that there was an immense quantity of gas; that the mine was making that gas, and that at a certain regular ratio; so that it was not a sudden burst, but a regular feed from all parts of the coal.

Mr. TAYLOR—No doubt that was the fact.

Mr. REID—Therefore the time in which such quantity of gas was coming off was very important. The subject of Mr. Taylor's paper is an important one. We have all at times seen gas, but are ignorant of its origin. One step is taken by this paper to ascertain in what direction the gas comes from, whether by spontaneous combustion in the mine, or whether it accumulated by the internal heat of the earth, or by some other means. No doubt one element in the issue of gas from dykes where there was a feeder of water, was the water itself. A very small quantity of water may dam an immense quantity of gas back. Mr. Greenwell has suggested to me to ask Mr. Taylor whether, in his opinion, if the mine had been longer in an abandoned state, there would have been a much larger emission of gas?

Mr. TAYLOR—I think under the particular circumstances of that mine, as explained in the paper, the probability is, that the gas was escaping by some extraneous means or other. There was some "broken," and means of escape might be provided in that way. Without entering into the question at large, he believed the gas did continually issue from the coal, and the reason why it did not assume a higher tension was, that it escaped at four-and-a-half atmospheres. As Mr. Dunn suggested, and also explained in his paper, part of the discharge would take place through the

* On the 10th March, the water reached the *confined* air space of the mine, the air and gaseous products having been previously drawn off by the pipe apparatus laid down for that purpose. On the 14th June, the Bensham Pit was filled with water up to the high seam. On the 15th November, the water began to be lifted out. On the 7th of the following March, the water-blast took place.

water itself, so that they could not ascertain from that particular experiment the tension capable of being assumed by the gas, or how long it would be before the gas and water were in equilibrium. Gas would also be absorbed by the water, and that would keep down its tension. He had no doubt the gas was issuing the whole time.

Mr. REID—It was very important to have the area of coal, and the time during which the gas was accumulating.

Mr. TAYLOR—With regard to the maximum tension, the highest tension he had heard or read of was a case related in *Silliman's Journal,* where a column 400 feet in height was displaced by carburetted hydrogen gas. That amounted to twelve atmospheres. In the other case, it was only 4½ atmospheres, which was the highest he knew of it assuming in a mine. There was no doubt the gas issued all along, and as soon as the tension of the gas balanced the column of water in the shaft, it escaped.

The PRESIDENT—The elasticity of the gas would overcome the pressure of water, and so create the water blast; but that does not show what was the tension of the gas *in sitû;* it was no doubt very much higher.

Mr. TAYLOR—We have a right to assume that the gas issued all the time. It might have issued to the extent of 10 or 12 atmospheres.

The PRESIDENT—That is if there had been a sufficient height of water.

Mr. TAYLOR—When we had an opportunity of measuring it, it was at four-and-a-half atmospheres. That is noticed in the paper, and so far is an answer to Mr. Reid's question.

Mr. REID—In that case I think we cannot doubt that gas does issue at an immense pressure, without reference to dykes.

Mr. TAYLOR—It becomes a modification of the same thing. The gas exists *in sitû* in a high state of tension, and escapes through the capilliary pores of the coal gradually. Sometimes, however, it comes off with great force, as in the case mentioned by Mr. Easton just now.

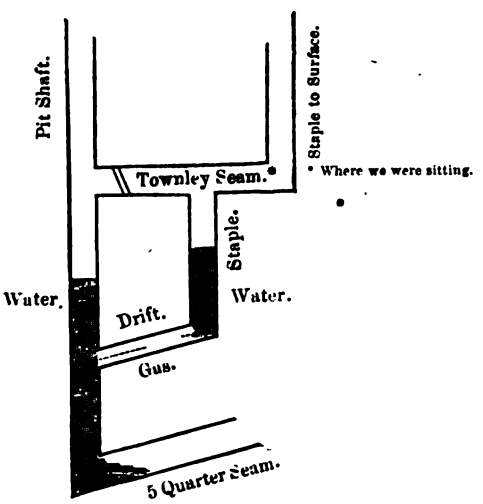
Mr. DUNN—Is the water-blast ever known to take place until the water column has begun to be lowered by pumping, or does it take place by a gradual accumulation of gas?

The PRESIDENT—In this case it did accumulate.

Mr. DUNN—But suppose the water had not been lowered, and the gas had been allowed gradually to increase, would the water-blast have taken place? Can any gentleman give us an instance?

Mr. HALL—Yes, I can do so. At the Townley pit, about 30 years ago, which is from 60 to 70 fathoms in depth, a drift had to be driven for air-way in a fiery seam, to another smaller pit, or staple. After the

drift was holed through from the pit to the staple, the gas issued out of the coal so strong, that it accumulated in the drift; and, the engine having to stand, the water coming down both the shaft and the staple, got several fathoms above the level of the drift in each. The water in the shaft being heavier than that in the staple, the gas getting stronger and stronger in the drift, lifted the water in the staple, up to the top, a distance of about twenty fathoms, where I, Thomas Robson, overman, and several others were sitting. The continuation of the staple being not directly above at the point where we were sitting, the body of water spread in all directions, forced us away from the place where we were sitting; and then, being no other outlet by the staple, the water returned into it. The water in the shaft, on the gas escaping, rushed into the drift and filled it, meeting that from the staple, and leaving a portion of the water still in the shaft and the staple, above the mouth of the drift at each side. The gas still continued accumulating in the drift, and when it became strong enough, again lifted the water, until the engine drew it off below the drift. Mr. Hall illustrated his observations, by means of a diagram, of which the following is a copy :—



The President—That would be a case of the gas having lifted a column of water twenty fathoms in height.

Mr. Taylor—Still it does not shew the maximum tension of the gas. We do not know what the maximum tension is. I may refer you to a passage in my paper, put in with reference to that subject. "A question

arises as to why the elasticity of the confined gas was between four and five atmospheres, and not more or less? I apprehend that this tension is in the particular case, to be regarded as a *minimum;* for in so large a mine space, where some pillars had also been removed, means of escape might be created for the gas, which did not exist previously to the opening of the mine. It is not improbable even that a portion of it penetrated the interposed water barrier, because æriform bodies easily find their way by absorption into that fluid, especially under pressure. These circumstances, rather than a want of sufficient tension in the gas, may assist, in the present state of information at least, to explain why a water-blast did not take place when there was a considerably greater depth of water in the shaft, than that under which the erruption actually occurred.

Mr. Jas. Longridge—It appears to me as if the gas had been cooled from the coal or come off suddenly, because in the first instance it would be compressed in the workings of the mine, and it would not be until the water was lowered to a certain point equivalent to the tension of the compressed gas, that the gas would reach the bottom of the shaft. Now, if their had not been a sudden evolution of gas from the coal, it ought to have passed off gradually, but, as I understand, it came off suddenly in a large quantity and with great violence. I do not think it would have done that unless there had been a great and sudden discharge or evolution from the coal. It would have remained compressed in the workings, and as it was gradually cooled, would have escaped gradually by the shaft and without explosive violence. I cannot reconcile the facts as set forth in the paper with the assumption that there was no extraordinary discharge from the coal

The President—The fact was, the elasticity of the gas was overloaded. Suppose the water pressure in the first instance was greater than the pressure of the gas, if that extra pressure were removed, then the pressure of the gas would put the water in motion; a much stronger power would be required to put it in motion when at rest; then, when once it got into motion, it would come off in a water-blast. They knew that water-blasts did take place where there was no discharge of gas whatever. If you have pent up in a close place a quantity of atmospheric air, and you remove the pressure from the air, you will find that in some way or other, you will have what may be termed a water-blast, although there is no increase of gas at all. Valuable as this paper is, I think it by no means proves what the tension of gas is *in situ*. [Mr. Taylor—Clearly not.] I think it far beyond four-and-a-half atmospheres. I think if they had not commenced pumping, the elasticity of

the gas would have lifted the whole of the water. [Mr. TAYLOR—Provided it did not escape by some other channel.] The elastic force of the gas, as Mr. Easton had shewn, was far beyond four-and-a-half atmospheres; that pressure would not have thrown off 2½ tons of coal.

Mr. EASTON—We did not ascertain the weight of the coal thrown off. It was broken into fragments and scattered about. I recollect a case where the gas came off several feet below the water, which ebbed and flowed as regular as the vibrations of a pendulum, and when the gas came off the water fell.

The PRESIDENT—This paper does not shew the utmost tension of which gas is capable, and I am sure the Society would be indebted to any gentleman who has any experience of facts relating to the subject for the information. It would also be very desirable if members would communicate such facts to the Society when they do occur.

Mr. GREENWELL—There has been a fact stated to-day which shews that gas does exist in a state of very high tension.

Mr. LONGRIDGE—I believe that the gas exists either in a solid or liquid form.

Mr. TAYLOR—I quite agree with you that it may exist in that state; but I was anxious not to mix up theory with the consideration of the question.

The PRESIDENT—You think it may exist in a solid or liquid state?

Mr. TAYLOR—Yes.

Mr. REID—I believe Professor Faraday tried with a pressure of fifty atmospheres to solidify carburetted hydrogen, and failed.

Mr. EASTON—Professor Faraday liquified bicarburet of hydrogen gas, with a pressure of 39 atmospheres, under a temperature of *minus* 77 degrees. He could solidify carbonic acid gas, but he could only liquify bicarburetted hydrogen.

Mr. REID—Mr. Taylor advocates the Safety Lamp to a greater extent than he does ventilation. Now, I think there is an impression out of doors that unless we can ventilate in some better form than at present, we should use the Safety Lamp altogether.

Mr. TAYLOR—I have stated in the memoir with regard to ventilation—"That no portion of this memoir is intended to disparage improvements in mine ventilation. On the contrary, the most efficient practical development of a ventilating system is held to be necessary, not only in fiery mines, but in those yielding incombustible gases, perhaps equally wasteful of human life. One of the results of the line of argument in this paper is to shew that a superior ventilation is required to dilute and remove the

ordinary issues of fire-damp; but what is also contended for is, that we must not attempt to carry ventilation beyond its legitimate object, the real question being, whether we are justified in encountering an enemy of so powerful, and yet so insidious a nature, as the one we have described, without some protection beyond that of a good ventilation." No doubt ventilation was desirable, but where gas existed *in sitû*, not with a pressure or tension of four atmospheres only, but, as he believed, with a tension of twenty atmospheres, or more, it is absolutely necessary to use the Safety Lamp.

Mr. Reid—I have had an instance in which the gas came off with such a pressure, that the Safety Lamp was almost valueless.

Mr. Taylor—You mean near the point of issue. But that is not the question. The gas travels until it becomes mixed with the atmospheric air comes in contact with the light, and an explosion is the consequence.

Mr. Dunn—That establishes the utility of Lamps. What would you do with naked lights in such a case, when the gas has reached the explosive point?

Mr. Reid—We were obliged to use naked lights in the case alluded to.

Mr. Taylor—In consequence of the quantity of fire-damp?

Mr. Reid—No; under circumstances which shall be hereafter communicated to the Institute.

The President—There is no doubt Mr. Taylor has protected himself quite strong enough with reference to ventilation, because he certainly does say, "depend upon ventilation in cases where ventilation is useful, and where it is complete." But there is one expression which rather tends to lead to the conclusion which Mr. Reid mentions—"What is contended for is, that we must not attempt to carry ventilation beyond its legitimate object." I suppose what Mr. Taylor meant by these words was, that we should not rely upon ventilation in such cases, but resort to something more than ventilation. There is no point of ventilation where we ought to stop. [Mr. Taylor—Not at all.] The greater the ventilation the better. [Mr. Taylor—By all means.] But, that we should not entirely rely upon ventilation, but also rely upon the Safety Lamp. I am glad Mr. Taylor has been called upon by Mr. Reid to give this explanation.

Mr. Taylor—The whole paper tends to that conclusion.

Mr. Dunn—It amounts to this. Suppose a set of fiery workings, and an abundant supply of air going through the workings, the question arises, is it the best practice to work with naked lights and a good ventilation, or is it better to work with Safety Lamps, with or without blasting—I mean in the face of workings which require to be bratticed

to keep them safe, but where there is abundant ventilation going on. Some persons perhaps are working with Lamps, some with naked lights, where should the line be drawn, under the expectation that some of those places would discharge suddenly gas, which Mr. Taylor says exists there in a high state of tension.

Mr. TAYLOR—No doubt there would be difficulties, as Mr. Dunn states, in drawing the line. There is difficulty also in saying what collieries yield gas of great tension, and what yield it in the more common or liberated form. There is the same difficulty in establishing the line in both cases. But, sometimes the line is established already. At Haswell Colliery, for instance, that is a case where 35,000 cubic feet of atmosphere was rendered inflammable in a few minutes.

Mr. DUNN—But I think in certain parts of it the boards are worked with candles.

Mr. TAYLOR—In that case, the ventilation was at the rate of 4½ feet per second.

Mr. DUNN—How many cubic feet per minute?

Mr. TAYLOR—About 9 or 10,000.

Mr. DUNN—Now, with a greater amount of ventilation—and this is a matter in which I feel greatly interested, on account of my official position—with a greater quantity of air going through the workings, and a number of men are employed, is it a proper practice to work with candles or lamps, and ought blasting with powder to be permitted or not?

Mr. HALL—We ought to have that from the Inspector himself.

The PRESIDENT—I was just going to say so.

Mr. TAYLOR—Will the Inspector inform us what is a good current of air?

Mr. DUNN—About 10 or 12,000 cubic feet per minute.

The PRESIDENT—I think the subject a very important one, and deserves a separate discussion.

Mr. TAYLOR—I have been accumulating more facts upon the subject, and I shall be happy to take an early opportunity of bringing the subject again before the Society. I think it will be better to defer the final discussion till that time.

The PRESIDENT—Then I think we may close this discussion now, and proceed with the reading of Mr. Hall's paper.

The following papers were then read :—

IMPROVEMENTS IN COLLIERY WORKINGS,

AND OBSERVATIONS ON

SAFETY LAMPS.

THIS Society, numbering amongst its members many of the most experienced and able mining engineers in the United Kingdom, comprises also a great number of persons who are engaged in the immediate direction of large collieries, and however important the questions of lighting and ventilation undoubtedly are, it is not the less so to illustrate the economical system upon which collieries are worked.

A correct understanding of this is essential to the future development and prosperity of that great branch of national industry, the Coal Trade. With this object in view, I beg to offer the following remarks, premising that I do so on general principles, and with a view to illustrate what I conceive to be correct rules, and without any invidious feeling towards individuals or parties. The interests of humanity, and justice towards the labouring colliery population, demand that every precaution against danger to life or limb, shall be taken which art can suggest and money command; and it is an honourable trait in the character of the coal owners in the North of England, that they have ever exerted themselves to attain this object; but besides providing what is due to the safety of their workmen, their own advantage, intimately involving that of the public, ought also to be fairly considered.

I will first refer in general terms to what I have effected in reducing the working charges of collieries, since my connection with the Coal Trade began, about 26 years ago. These are noticed in the pamphlet I have recently published, on the Safety Lamp; the extensive changes and reforms which have been carried into effect since that period have far exceeded those introduced in the other coal districts of the United Kingdom; they have been successful as well as extensive, and the expenditure of capital proves to have been as judicious and profitable as it was liberal.

These improvements resolve themselves into two branches, the saving

of working charges, and the remuneration for capital invested; and the means by which they have been effected were as follows:—

First, the abolition of the use of corves and the substitution of tubs with carriages attached thereto, having wheels suitable for edge underground rails instead of the old system of trams and tram plates.

This had been attempted by the late Mr. Thos. Easton, at Hebburn Colliery, about the year 1827; but, in consequence of the difficulties of conveying loose corves upon trams, and the objections of the boys employed as putters to continue their employment, he was compelled to fall back upon the former arrangement, and which continued up to the time when I introduced the new plan at South Hetton, Townley Main, and Whitefield Collieries It was then also taken up at Hebburn by Mr. Jas. Easton, son of the late Mr. Thomas Easton, who then again introduced it into that and every other colliery of which he has the charge; and, in fact, it has now become universal throughout the trade in this and many other countries.

This improvement led to others. The one next in importance to the adoption of tubs was the construction of shafts, in pits, with perpendicular guides, so as to admit of the raising and lowering of cages attached to the ropes with great rapidity, and without any undulation in the shaft.

The former mode of slinging corves, with workmen and boys, up and down the pits, was very objectionable and dangerous—so much so, indeed, that no set of men could now be induced to return to the practice.

The third improvement was, that the guides secured such uniformity and dispatch, that one engine, and one pit or shaft, were enabled to perform double the work that had been done before, in even these two counties. I understand such can be now proved, by Mr. William Anderson and Mr. N. Wood, to be the case at Harton Colliery, near South Shields, 1300 feet in depth, and Killingworth Colliery also; and which I believe to be three times greater in depth, and to yield four times more per annum per pit, than upon Mr. Curr's plan, adopted in the year 1794, near Sheffield. The guides, on my plan, became so safe as to produce great regularity and quickness, and, by concentrating the powers of the colliery more fully upon one focus, simplified and cheapened every auxiliary operation. Upon this foundation, every other contingency, so far as relates to the expenditure of capital, depends, no matter in what situation. If even there were off-shoots from the pit which were unsuccessful, all the weight will be thrown upon the stock, which must more or less bear the burden.

Other collateral advantages, though not all of the changes just de-

scribed, will be found in the following particulars: a larger quantity of coals can be much more safely and easily conveyed in tubs with suitable wheels, than by corves, with an improved and lighter line from the face of the coal in the various workings to the bottom of the shaft, thus abolishing the expensive system of conveying coals in bogies, drawn by horses, upon a heavier line of rail, and lifting the corves by crane, from the bogies to the tram, where the putter took possession of them, and *vice versa.*

The system now in operation is to employ large horses, where the seam is suitable, or where roads sufficient for the height of the horses have been cut, to the places where the cranes stood, putters and Shetland ponies being substituted, from that point or station to the face of the coal, to draw tubs, with bogie wheels upon light edge rails, instead of corves conveyed loose upon trams, along common metal and malleable iron tram plates, on wooden ways, as formerly.

This system also admits of the employment of self-acting planes or steam machinery with small wire rope, with greatly increased simplicity, facility, and cheapness, and it is attended by this satisfactory reflection, that it is not likely, at all events very speedily, to be superseded by any other.

By the agency of this system, the pits at Townley Main and Whitefield Collieries, about 500 feet deep, twice the quantity of coal per annum was produced from one pit that had previously been produced from two, under the former system; and at South Hetton, 1,100 feet deep, it performed double the work ever effected, of that estimated for any pit similarly circumstanced.

Neither colliery owners nor any other persons throw aside plans that have answered well until superior ones are devised, and nothing of this kind has yet been discovered, nor even hinted at, up to the present period; nor do I find any other improvement done, or suggested, even by our Government Inspector, Mr. M. Dunn. The modes of carrying out the improvements described differ according to the varied requirements of the respective pits: those most suitable for pits in general are shewn in the plans and diagrams prepared by Thomas Sopwith, Esq., and which accompanied a model of my design of a pit shaft with guides and cages, constructed by that gentleman some time ago, exhibited (as may be remembered) at the Polytechnic Exhibition of Newcastle, and afterwards deposited in the Museum of Practical Geology, in London, where they are open to public inspection.

To shew of what vital importance these changes have proved to the Coal Trade, I may be permitted, in substance, to repeat the statement

made in my pamphlet—observing that it would be easy for me to enumerate names and instances sufficiently well known to silence doubt or objection were that statement impugned.

There can be no question that, during the last 20 years, many collieries have been compelled to sell their produce from a third to a half less price than they obtained previously, and it must be obvious that it would have been impossible for them to have done so, had it not been for those reductions in the working charges upon which I have dwelt, and which have effected a saving to the coal trade in the counties of Durham and Northumberland, estimated at least three-quarters of a million sterling per annum.

London, which, 20 years ago, required two millions of tons of Coal per annum, up to the present time, this year, has had four millions.

It would not cost much trouble to enumerate the few colliery owners, for few they have been, who have paid expenses, besides the loss of interest, upon the enormous capital embarked in colliery enterprises. The vicissitudes and vexations to which they have been annually exposed, and the augmentation of their capital accounts by the addition of the losses they have sustained.

Viewing the case through this medium, I greatly fear that, instead of my former views on these points having been overcharged, it will be confessed they have rather been underdrawn.

So enormous indeed has been the loss accruing from coal mining operations, that in Fordyce's History of the County of Durham it is stated, that nearly two millions sterling have been exhausted and wasted in this manner by two joint-stock coal mining companies, the proprietors never derived a farthing from the undertaking, to say nothing of disappointed hopes and misapplied energies.

But passing away from this topic on which too many cases of a like nature might be mentioned, let us look at one of more immediate and practical importance.

Assuming, as I have high authority to do, the capital in the Coal Trade at this time, in the Counties of Durham and Northumberland, to be £13,000,000, without Public Railways that have got acts of Parliament, and have bought their own land, (£12,000,000 is too low a computation), taking all circumstances into account, and assuming the gross quantities of coal raised to bank at 13,000,000 tons, taking also the per centage upon capital, for interest, risk, and redemption of capital at 7½ per cent., (as stated in my former paper), the amount is equal to 1s. 6d. per ton, or upon each pound sterling, which is 7½ per cent.—about double the sum

named in my paper: even at 5 per cent., it would be about 1s. or 1s. 1d. per ton; which is double what I have estimated and stated, on the £25,000 and £50,000 capital alluded to below for 100,000 and 200,000 tons per annum, for one pit, &c., upon an improved system at full work.

Suppose the capital to be only 12 millions, it would not be much less.

This will clearly shew that I take a low basis when I state the capital required to produce 100,000 tons to be £25,000, and to produce 200,000 tons £50,000: the average is calculated by me upon these capitals and the improved system being 6¾d. per ton, for each pit at full work. Again, I am satisfied that my estimate of the reduction of working charges was underrated at three-quarters of a million, which is equal only to about 1s. or 1s. 1d. per ton on the aforesaid quantity. I found this conclusion, upon my own practical experience, in extensive concerns of which I have had the management, and many others within knowledge. Twenty years ago, the best coals were selling at double the present price; ten years ago they experienced a decline; and since that period have not averaged more than half the price paid twenty years ago, and for some time after that. This was the case both in England and other foreign countries. Within the last six months, there has been an universal change for the better.

I mention this to shew that many additions to capital account must have been made within the 10 years to which I refer, which would certainly have been greatly increased but for the improvements I was instrumental in establishing in working the collieries in the Northern Coal Field.

If these facts be worth any thing, they shew the importance of persevering in a similar course of improvement wherever the door to it may be opened, assuming that we would maintain the northern counties in the high position they have hitherto held in the Coal Trade.

If I have not already trespassed too long upon your attention, I shall feel obliged by your granting me your indulgence for a short time longer, while I make a few observations upon the Miners' Safety Lamp.

I have it from good authority, that four-fifths of our mines are worked by them; and the same authority states that the whole of our coal mines would be so if a good safety lamp with gauze (not glass lamps) were provided. Such a lamp, I have for some months past, been engaged in bringing to a state, which at length justifies me in recommending it to the consideration of our Inspector of Mines, and to all classes concerned in mining operations, as one combining greater brilliancy with greater safety than any by which it has been preceded. After the copious details and

illustrations of the invention which have appeared in the papers printed in the Transactions of the Mining Institute, and in other publications, I feel it to be wholly unnecessary, at the present moment, to enter into any relation of technicalities, and would rather confine myself to a statement of the opinions of its merits concurrently expressed by some gentlemen, whose judgment, based upon long and matured experience, would entitle it to my submission, even if it differed from my own, but which, I may be allowed to say, has still stronger claims to my respect since it coincides with my own opinion. Amongst the gentlemen I allude to, I may be permitted, I hope, to mention our President, Nicholas Wood, Esq.

The following Gentlemen have expressed their approval :—

Messrs. Thos. John Taylor, Mining Agent to Duke of Northumberland.
" Thos. Sopwith, Chief Mining Agent to W. B. Beaumont, Esq., M.P., and Commissioner to the Crown under the Dean and Forest Act.
" Wm. Anderson, Mining Agent to Earl of Lonsdale, &c., &c.
" Hy. Morton, Esq., Chief Agent to the Earl of Durham.
" Geo. Elliot, Mining Agent to Marquess of Londonderry.
" R. Heckels, Mining Agent to Earl of Durham.
" Thos. Wood, Managing Owner at Ludworth & Thornley Collieries.
" John Dobson. Architect, Newcastle-on-Tyne.
" John Robson, Managing Owner for several Collieries.
" Edw. Potter, Do. Do. Do. Do.
" Wm. Barkus, Mining Agent, Gateshead Fell do. do.
" M. Liddell, Mining Agent for Gosforth and Mickley Collieries.
" Jas. Easton, Mining Agent for Hebburn and Gateshead.
" Wm. Armstrong, Mining Agent for Lord Howden, Wingate Grange, and Castle Eden Collieries.
" Thos. E. Forster, Mining Agent for South Hetton, Seaton Delaval, &c.
" Thos. Storey, C. E., St. Helen's, Auckland.
" P. S. Reid, Viewer, Pelton Colliery.
" G. C. Greenwell, Viewer, Mining Agent to Messrs. Bowes, Wood, and Palmer, Marley Hill and other Collieries.
" Robt. Simpson, Redstock Colliery, near Bath, and Managing Agent to the Stella Coal Company, at Townley and Whitefield Collieries, Ryton, County of Durham.
" Wm. Watson, Viewer, Newcastle-on-Tyne.
" Hy. Watson. Manufacturer of Safety Lamps, &c.
" J. Abbott & Co., Do. Do. Do.

Messrs. Wm. Hunter, Mining Agent for several Collieries. "You have attained two great desiderata, increased light and perfect safety."

" Dr. Richardson, Newcastle-upon-Tyne.

" W. G. Armstrong, F.R.S., Do.

" Robt. Hawthorn, Esq., Engineer, Do.

" Wm. Hawthorn, Esq., Do., Do.

Also two others, formerly pitmen. One of these is now a viewer: the other, when a boy, was enployed to work a steel mill, to light the hewers at their work in the mine at Wallsend Colliery. Two others, eminent borers, George and Rawling Stott, Ferryhill, Durham, came, half an hour ago, to get one of my lamps, to enable them to judge of the different quantities and qualities of gases let off while boring through the different stratifications of stone and coal seams. They are now boring where they expect to approach a Coal Seam, formerly worked to a great extent, and filled up with water. They contemplate that the gas accumulated therein will be corked up, so that the tension in situ will be very great, and the same will come up the bore-hole, when approached with the bore-rods. In this or any similar case, it may be ascertained when gas is coming off, either in large or small quantities, by closing up the hole all round the bore-rods, and having a small pipe connected with a hole; and also by a tap-cock to let the gas into the Safety Lamp, the flame of which will thereby be so much changed in appearance as to indicate its presence. I may here add, that the above list contains the names of nearly all the gentlemen to whom I have shewn my improved Lamp. All of them have had opportunities of personally testing its qualities; and I believe they will not be disinclined to continue to bear testimony in its favour.

I shall be glad to have an opportunity of shewing it to the members of the Institute, and to any other person who may have a desire to form his opinion upon his own inspection, rather than to take it from the dictum of others, however high in professional character or position. I do not say this from any wish to exalt my Lamp unduly in the estimation of those who hear me; but I wish my invention to be judged by its own merits—by nothing more and by nothing less—to have, in short, a fair field and no favour. We know that there may be a disinclination to disturb the state of things that has prevailed since the introduction of Sir Humphrey Davy's, Stephenson's, and Upton and Roberts'—Gauze Lamps, like my own. I find among some papers which have been placed in my hands by the widow of the late Rev. John Hodgson, Rector of Heworth, a series of memoranda kept by him, from the time of the Felling Colliery explosion about the year 1812, until after Sir H. Davy's and Stephenson's Lamps were made, that our President had something to do in assisting to invent or make the latter—a plan of which I now produce, with the like originals of Sir H. Davy's, and with a

diagram of my own; also the Lamp itself. I have also a Hot Oil Lamp which answers well, and my Dioptric Lens Lamp, I may be able to produce to your notice next meeting: in the meantime, any one is welcome to see it at any convenient time. But it must be remembered, that these, too, were innovations upon the previous use of pit candles, forty to the pound, and steel-mills in dangerous places, the latter of which only emitted sparks of fire instead of flame. So far as my Lamp is concerned, I will venture to repeat, in conclusion, that I now feel assured of success. I am diffident at all times of expressing strong opinions; but in this case I am firmly persuaded that it will be a boon long wanted in the mining world, and prove largely instrumental in the preservation of life and property. Fortified as I am by the opinions expressed by the eminent individuals whose names I have mentioned, I invite the public to favour me with their encouragement. Utility, at last, is the test of merit, and to that test I cheerfully submit the product of my labours. It is not alone for the preservation of life that an improvement in lighting is required, although that, of course, is of the very first importance, but for the advantage of the colliery owners themselves, whose pecuniary interests invariably suffer largely whenever an explosion takes place.

The damage occasioned by the blasting of a mine is much more considerable than persons unacquainted with colliery operations can possibly conceive. The derangement occasioned in the workings and air-ways of the pit is almost always such as to require great expense and time to restore them to their former condition. This occurs in ordinary cases; but in more severe explosions the shafts and air brattices are also injured; and before the damage thus caused can be remedied the colliery is frequently laid off for a considerable time, during which all the establishment charges, rents, interest and other fixed payments, keep of horses, &c., &c., have to be sustained, though not a ton of coal is drawn. Although I have had the good fortune to avoid explosions in the collieries with which I have been professionally connected for upwards of thirty years, yet I have been employed to restore, and assist in restoring some in which casualties of this kind, of the most injurious description, had occurred; and I can therefore speak without reserve as to the greatness of the stake which colliery proprietors, from mere regard to their own interests alone, and without reference to other considerations, have in the safe working of their mines, and in the use of lamps which shall be satisfactorily shewn (as mine I am satisfied can be) to afford the best light, with the greatest security from dan-

ger. In this district, I may refer to Townley Main, Whitefield, Washington, and Wallsend Collieries, in support of my observations upon this point. But the most serious explosion, perhaps, that ever occurred in any part of the world, was that of the Blackheath Pits, Chesterfield County, Virginia, U. S., when the amount of loss, in injury to mine, sacrifice of life in negro workmen, and horses, derangement and long suspension of the colliery, loss of profit, interest, &c., &c., did not fall short of £40,000 to £50,000. I would refer to two other mines, the Etna and Mid-Lothian, adjoining from East and West, to Blackheath; of which I had not the management at the time when the explosions and fires occurred, but in one of which (the Mid-Lothian) the most deplorable consequences ensued. In each case the managers had given up the mines; but the fires were extinguished under my advice and superintendence. In the Blackheath pit, the gas, in 1839, when I cleaned this mine, was in the whole of the workings, which varied in height from 12 to 29 feet, and the gas came out so strong, to the bottom of the shaft, that it prevented any person from approaching further, until I undertook the work six or eight months after the calamity occurred. I then took out the gas, also the dead bodies, 70 or 80 in number, horses, &c., and set the pit to work again.

The Mid-Lothian pit, close adjoining Black Heath pit, was exploded from a naked light setting fire to the coal, which came in contact with the brattice, conveying air down one portion of the shaft and up the other, after going through the workings. In this case, I succeeded in rescuing one of the agents, and also a number of the workmen. After the manager and his son had abandoned it, the brattice referred to was burning, and burnt out for 50 or 60 feet opposite the furnace drift, whilst I was bringing up those whose lives were thus placed in the most imminent peril. The danger was so great, that the flames would in a few minutes have reached the top of the pit, had I not given orders to close it, even before the horses could be extricated. This pit was closed about six months before it was thought prudent to re-open it, in consequence of the standing coal being on fire near the bottom of the shaft, when the pit was closed; but before many weeks had elapsed the gas made in the mine filled the whole of the workings, and came up to the top of the pit against the covering placed over it twelve feet above the surface of the ground: the walling for that twelve feet not being tight, the gas issued 20 yards through it, got into the engine house where naked lights were placed, and ignited there. The Blackheath pits, where I am still largely interested, have suffered similar disasters several times since I left the management, even up to the present time.

PLATE. I

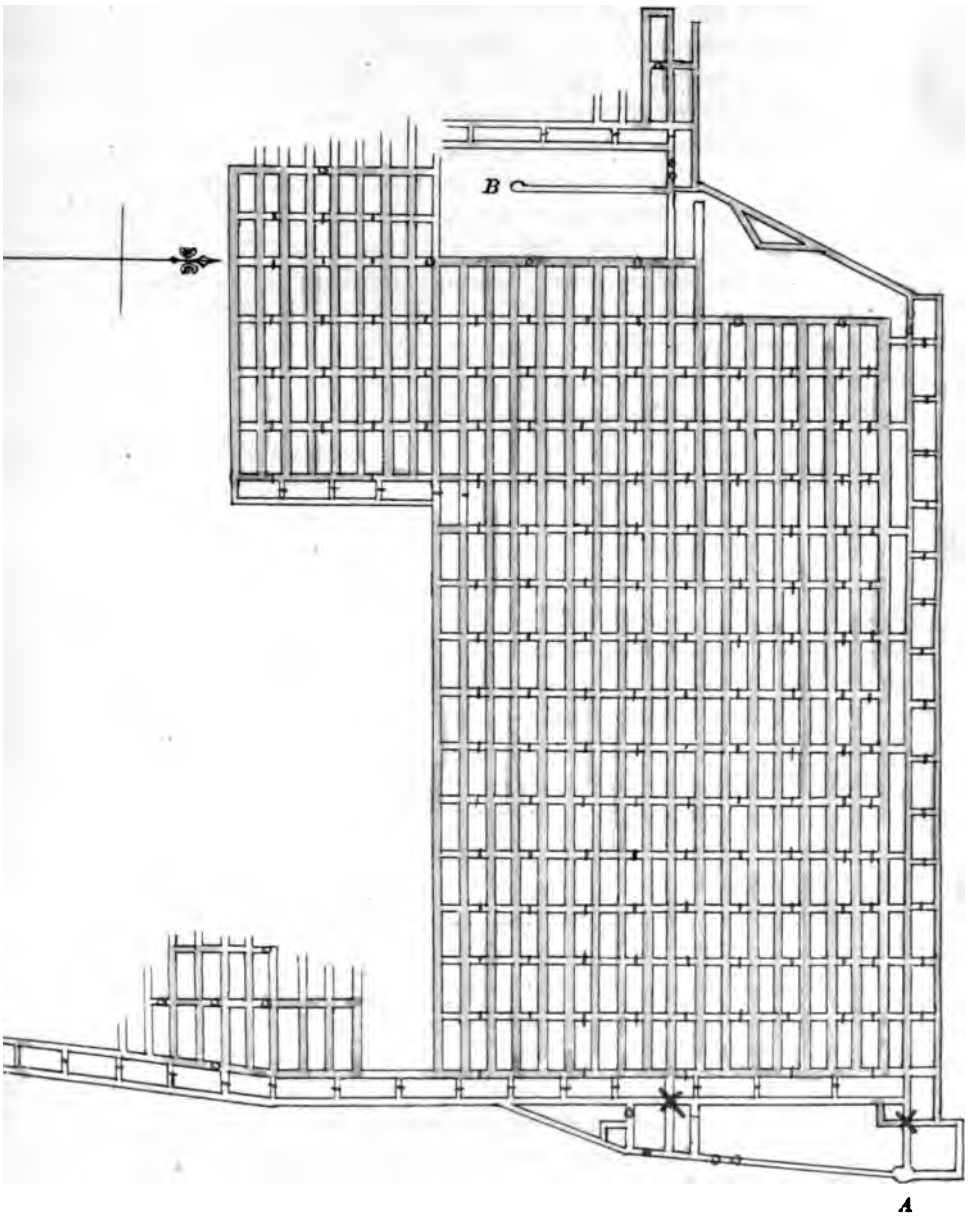
PLAN

OF THE WORKINGS AT

FELLING COLLIERY,

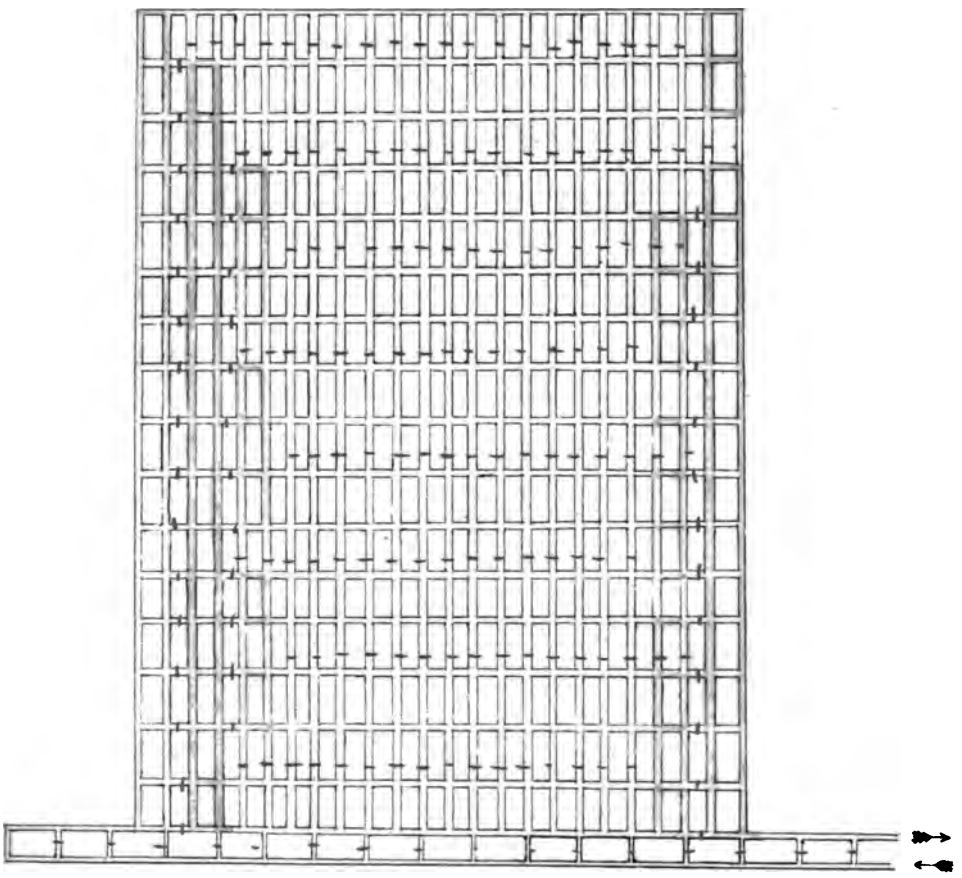
MAY 25, 1812.

Ascending Courses coloured Red.
Descending do. do. Blue.



(From Rev. J. Hodgson's account of the Explosion.)

Ascending Courses coloured Red.
Descending do. do. Blue.



It is a great mistake, therefore, to suppose that the agents or owners of collieries can be indifferent to the safety of their workmen, seeing how closely it is interwoven with the protection of their own property, and the extent to which this may be affected, by catastrophes which have alike destroyed life and property. Still, I would respectfully repeat, that, although much has been unquestionably done to guard against these destructive visitations, much yet remains to be done.

The Lamp to which I here draw your attention (I am afraid at somewhat too great length), and for which I have obtained the protection of a patent, as also, I may incidentally mention, for the consumption of smoke, appears, according to the authorities which I have mentioned, and the tests which it has undergone, to combine, in the greatest degree yet discovered, increased light with increased safety. I have no hesitation in expressing an earnest hope that the Colliery Proprietors in the North of England may be induced to investigate and adopt the improvement which I have brought before them, and through them before the mining community at large: at all events, that they may both for their own sake and from a due regard to the valuable lives of their workmen, give my humble, but I trust useful, invention a fair trial.

T. Y. HALL.

OBSERVATIONS

ON THE GREATER FACILITY OF VENTILATING DIP, THAN RISE WORKINGS.

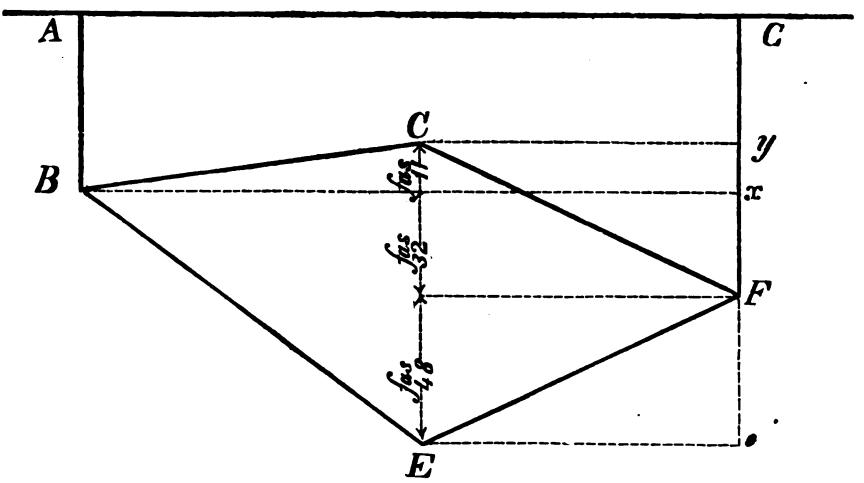
THAT the circumstance implied in the title of this paper is of uniform occurrence, is an acknowledged fact, the reason of which has frequently been discussed among practical miners, without, however, their arriving at any mathematically correct conclusions on the subject, the importance of which, when viewed aright, is not inconsiderable, as will be seen in the sequel.

In treating of this matter, I shall do so entirely apart from all considerations connected with the greater lightness or heaviness than atmospheric air of the gases met with in mines, and as the mere abstract question which it is my present object to elucidate.

The rise and dip of the strata forming the Newcastle Coal-field are in general so gentle, that we have rarely opportunities presented to us of making observations in point, upon an extensive scale, while it is under such circumstances alone that we are enabled, by the striking facts which we observe, to draw any just inferences.

The great elevation of the rise workings above, and depression of the dip workings beneath, the level of the bottom of the upcast shaft at Backworth Colliery, where, as the workings approach the 90 fathom dyke, the strata dip to the south at an angle of from 20° to 30°, afforded an excellent opportunity of examination, and, at the suggestion of Mr. Thomas John Taylor, I, in January, 1844, made the observations from which I obtained the results, which I now beg leave to submit to the notice of the Institute.

The relative position of the rise and dip workings, with regard to the upcast shaft at Backworth Colliery at the above date, may be represented by the annexed diagram.



A B.—The downcast shaft for the rise workings, depth 53 fathoms.

C.—The rise extremity, 11 fathoms above *B*, and 43 fathoms above *F*, the bottom of the upcast shaft.

G F.—A bratticed shaft; one side being the downcast for the dip workings, and the other the upcast for the whole colliery, depth 85 fathoms.

E.—The extreme dip; 48 fathoms beneath the level of *F*, and 80 fathoms below *B*.

Mean temperature of downcast for rise workings	43°·875
Mean temperature of downcast for dip workings	45°·937
Mean temperature of upcast	77°·5
Mean temperature of *B C*	53°·125
Mean temperature of *C F*	58°·5
Mean temperature of *F E* (Intake)	62°·25
Mean temperature of *F E* (Return)	66°.123

From these data we derive the following as being the comparative powers available for the ventilation of the rise and dip workings

1. *Rise Workings.*

The difference in weight between the downcast and upcast columns in this case, which produces the current of air through the rise workings, is expressed as follows :— *Feet.*

1. $\frac{(G\,F - y\,F)\ 77{\cdot}5 - 43{\cdot}875}{480 + 45{\cdot}5} = 16{\cdot}124$ feet of air at 43°·875=in air at 50° to .. 16·324

2. $\frac{y\,F\,(77{\cdot}5 - 58{\cdot}5)}{480 + 45{\cdot}5} = 9{\cdot}328$ feet of air at 58°·5=in air at 50° to ..... 9·171

3. $\frac{y\,x\,(53{\cdot}125 - 43{\cdot}875)}{480 + 21{\cdot}125} = 1{\cdot}218$ feet of air at 43·875=in air at 50° to ..... 1·233

26·728

of air at 50°, which is equal to a pressure of 2·6277lbs. avoirdupois upon the square foot.

2. *Dip Workings.*

The difference between the weight of the downcast and upcast columns is here as follows :— *Feet.*

1. $\frac{G\,F\,(77{\cdot}5 - 45{\cdot}937)}{480 + 45{\cdot}5} = 30{\cdot}441$ feet of air at 45°·937=in air at 50° to..... 30·691

2. $\frac{F\,e\,(66{\cdot}125 - 62{\cdot}25)}{480 + 34{\cdot}125} = 2{\cdot}170$ feet of air at 62·25=in air at 50° to ..... 2·118

32·809

of air at 50°, which is equal to a pressure of 3·226lbs. avoirdupois upon the square foot.

We have, therefore, a preponderating power as applied to the dip workings of 3·226−2·6277=·5983lbs. per square foot, which proves of course that so long as there was sufficient area in the dip airways to prevent the resistance of these workings offering any barrier to its progress, no air at all would pass through the workings situated to the rise.

Were the necessity, where practicable, of having upcast shafts situated to the extreme rise of a colliery not so universally admitted, it would be established by the experience of such facts as those given above. One

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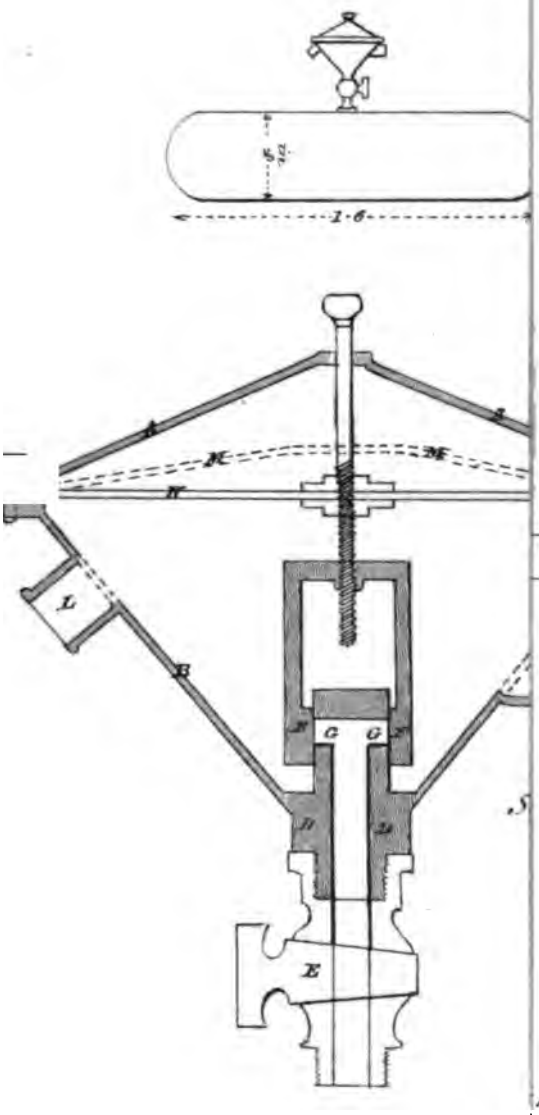
Fig. 1



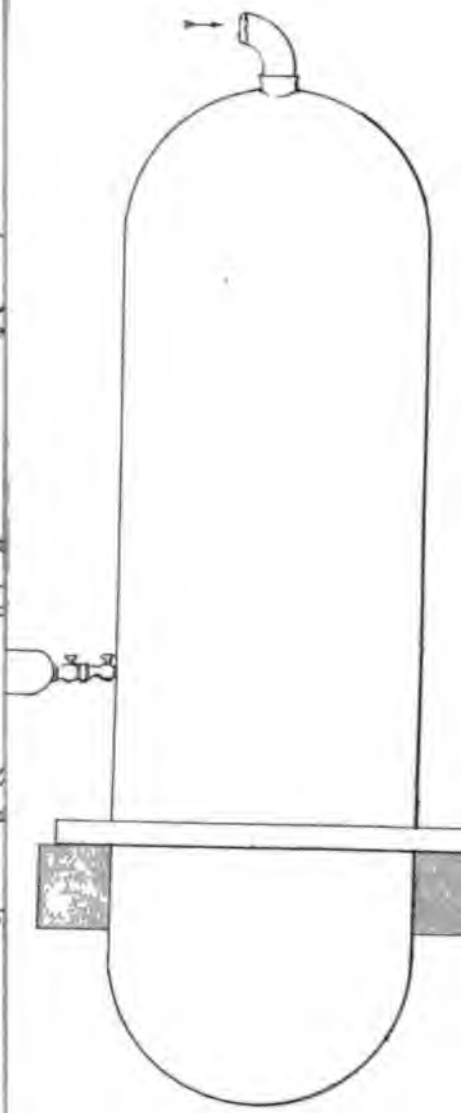


Fig. 4.

foot.

ON CHOKE DAMP,

AND THE MEANS OF

COUNTERACTING ITS EFFECTS.

BY JAMES A. LONGRIDGE.

THE attention of the members of this Institute, during the first year of its existence, has been chiefly directed to the subject of Ventilation, and particularly to the examination of the comparative merits of the Furnace and the Steam Jet as agents for that purpose. By the elaborate experiments which have been made, and the full discussions which have taken place, we may be content to leave that question as it now stands, and turn our thoughts to other matters; not that we are to sit down satisfied that we have done all that can be done to ensure safety to the miner, but that we have *proved* that so far as safety is dependent upon *quantity* of air, the question as between the Furnace and the Steam Jet is set at rest. There are other questions of great importance, such as the proper distribution of the air, the size of the air-courses, &c., which may well occupy our attention, and by bringing to bear upon them the vast amount of practical data already in existence, and which only requires collecting and classifying, there can be no doubt that a most valuable addition would be made to our knowledge of this branch of Ventilation, and that the degree and nature of the resistance which the air undergoes in its passage through the mine, might become a matter of strict calculation instead of vague surmise.

It is not my intention at present to enter upon this branch of the subject of ventilation, nor indeed upon that subject at all, but rather upon one cognate to it, and probably of equal importance. In looking over the immense mass of evidence which has from time to time been given

relative to accidents in mines, we are struck with the fact, that by far the greatest proportion of that evidence bears upon the modes of preventing explosions, and yet in the very same evidence is found the somewhat startling fact, that by far the greatest mortality attendant upon these accidents has been caused, not by the explosion itself—not by the fire—but by the consequence of the explosion—the after-damp.

It is stated by those of great experience that at least 70 per cent. of the deaths in fiery mines is to be attributed to after-damp, and by some this estimate is carried as high as 90 per cent. In the great Haswell accident, it is stated, that of 95 deaths 12 only were from fire, 12 from concussion, and 71 from choke damp, and there can be no doubt whatever of the fact, that by far the greatest proportion of mortality arises from this latter cause. It seems then strange that when such should be the admitted fact, and whilst so much should have been done to prevent explosions, so little has been done to palliate their consequences.

I believe that no amount of care, no amount of ventilation will *prevent* accidents from explosion, and this belief is strengthened by the perusal of the valuable paper read before the Institute by Mr. T. J. Taylor, on the State of Tension of Fire-damp in sitû. I entirely agree with the author of that paper, that looking at the proofs we have of the natural state of fire-damp being that of a high degree of tension, accidents are more likely to occur from a sudden outburst of gas from the whole coal, where probably for days previous no symptoms of gas had been seen than from the workings in the broken, which for a length of time had been subjected to a process of drainage, if we may so term it, by which the gas had passed gradually away; and I further agree with him in his recommendation that safety lamps should be exclusively used in fiery mines, and especially in the whole coal workings. Were this rule strictly adhered to, the number of explosions might probably be considerably diminished, but from time to time they would occur in spite of every precaution.

It therefore, behoves us to consider, in what way we may render them least fatal in their consequences, and as it is to the after-damp that the greatest mortality is attributable, I propose to myself to direct your attention in this paper to such means, as have been proposed, or as appear feasible, to avert its deadly consequences.

As some of the means that have been suggested are dependent upon chemical action, it is proper at the outset, to state briefly, the chemical nature of Choke Damp, and its action upon the animal economy.

Choke Damp, or after-damp, is a combination of gases in varying

proportions dependent upon the peculiar circumstances of each explosion, these gases are nitrogen, carbonic acid, (and perhaps in some cases, carbonic oxide,) carburetted hydrogen, and atmospheric air.

In some cases, those in which the fire-damp is mixed with atmospheric air in a certain definite proportion, viz.:—1 part of the bihydruret to four parts of air, the following is the product—

1 bihyd. carbon	1 of carbonic acid.
4 air.	2 of water.
	8 nitrogen.

$$H^4 C + 4 (O N^2) = C O^2 + 2 H O + 8 N.$$

If now a greater proportion of atmospheric air be present, it is evident that its excess must as far as the bihydruret of carbon is concerned, be undecomposed.

In other cases, when this excess exists, it may enter into combination with small particles of coal and coal dust set on fire by the explosion, and a large quantity of carbonic acid may be generated.

At times, probably generally, the evolution of fire-damp may continue after the explosion, and we would find it present in the Choke Damp.

Hence, we see that in certain circumstances, some of these gases may be in excess and in different circumstances others, and it is therefore obviously impossible to predicate the constituent parts of so variable a mixture, and this alone would be a ground for distrusting any appliance of chemical re-agents, were they in other respects applicable.

As regards the action of these gases on the animal system, a good deal of discrepancy exists between the opinions of different persons, arising chiefly from overlooking the above fact, that it is not with the pure gases we have to deal, but with mixtures in various proportions.

Nitrogen may be inhaled pure without inconvenience, but in an atmosphere of nitrogen a man would soon die for want of the oxygen necessary to produce a certain chemical change in the blood. Other gases, such as cyanogen phosp. and carb. hydrogen are simply poisonous. Others again, such as carbonic acid and chlorine, are not only poisonous, but in a concentrated form cannot be inhaled from inducing a spasmodic contraction of the glottis, but in a diluted form they may be inhaled without inconvenience, or at least some of them. Carbonic acid, for instance, when diluted with atmospheric air, may be respired, and the many deaths which have occurred from the use of the charcoal brazier for heating rooms, in which the sufferers have passed from life to death without a struggle, are proofs that this gas in a diluted form, though a deadly poison, may be inhaled without inconvenience.

Such being the nature of the atmosphere which supervenes in a mine after an explosion, and cuts off all communication between the workings and the shaft, the question arises in what mode we are to deal with it.

I think no practical man will deny the assertion that in the state of confusion in the mine consequent upon an explosion, where stoppings and doors are blown out and crossings destroyed, no general means can be effective. No operations carried on from bank by steam jets or fanners forcing air down the shaft, or by large pipes laid in to refuge stalls, can do much good. Practically we must descend the shaft, replace stoppings, and carry the air with us till we get to the workings; and, alas! too often get there too late.

Looking at the complicated magnitude of the workings in an extensive mine, and the derangement consequent upon an explosion, it does not seem to me that the difficulty that is to be contended with can be met otherwise than by the adoption of some system, *whereby each individual miner shall be rendered as independent of the influence of choke damp, as by the Safety Lamp he has been rendered independent of that of fire-damp.* His safety should not be based upon the perfect action of any general system, even were that ordinarily practicable, inasmuch as the failure of one portion of that system might be fatal, not to an individual, but to all—but each man should have his independent safeguard, which at any moment he might have recourse to. By this conviction I have been influenced in devising the apparatus now brought before you, but before entering upon its description I will advert shortly to the means already proposed, so far as they have come under my cognizance, for accomplishing the same purpose.

The first is that proposed by Mr. Elliott, in his evidence before the Lords Committee, in 1849 (3064), when he proposes, by means of pipes laid from bank, to convey to the scene of explosion quick lime and water, or oxygen gas, previously in readiness on the surface, for the purpose of absorbing the poison of the carbonic acid and imparting to the residual nitrogen a quantity of oxygen, which would render it fit for respiration. Now the first objection that occurs to this system is, that the remedy could scarcely be conveyed to the scene of the explosion. In an extensive colliery it would require a system of piping analogous to that required for the distribution of gas in lighting a town. The piping must be co-extensive with the workings, and a system of stop cocks would be necessary for each district. If all these cocks were left permanently open the gas or the lime water would be distributed over all the outlets, and probably but a small portion would reach the spot where the whole was

actually required. If, on the other hand, the cocks were kept shut, there would be no possibility after an explosion of reaching those which required to be opened so as to supply the materials required at the right place. But independent of this mechanical objection, there arises another of no less force. If it were possible to convey to the district—the scene of an explosion—by means of these pipes, a supply of lime water or of oxygen, I apprehend it would be impossible so to distribute these elements as to make them subservient to the preservation of life. In order that these reagents may be effective, they must be supplied, not only in large quantities and within a short space of time, but they must be brought rapidly in contact with the elements with which they are to combine and react. The lime water, to absorb the carbonic acid gas, should be spread over a large surface—should be distributed almost in the form of spray throughout the poisonous atmosphere—a condition quite incompatible with the mode by which, and the circumstances under which, it is proposed to be supplied; the oxygen gas again would equally require diffusion, and though diffusion is a law of gaseous matter, yet for that diffusion time is required, and in that time the life which it was sought to preserve would have perished.

Furthermore, could these difficulties be provided against, there still remains another, viz.:—the maintaining a constant provision of the chemical elements, in sufficient quantity at the surface, ready at a moment's notice to be brought into operation.

The next suggestion is that of Mr. Barkley, for refuge stalls, Lords Report, 1849 (4315). "The means I propose is a refuge chamber placed in the main intake of each panel, and supplied by artificial means with respirable air." And again, speaking of Robert's Safety Hood, he states (4316). "The principle of it was this: the carbonic acid gas was passed through lime water or chloride of lime, and in so doing the foul or destructive portion was precipitated and the oxygen set free, affording the agent necessary for the support of life." And he continues to describe the mode of application of the principle to the refuge chambers, stating (4320), "I would conduct the bad air (pressing in to fill the partial vacuum formed by the action of the pump) through a composition as described: The carbonic acid would precipitate and form chalk, while the oxygen would alone enter, and, by supplying the necessary ingredient, would prolong the inmates' existence for a sufficient period to permit of their being reached."

Now with respect to this Mr. Barkley seems to be under a misconception as to the nature of the action of lime water on carbonic acid gas. He

quantity of the carbonic portion being precipitated and the oxygen set free, as though the lime water had the power of decomposing the carbonic acid. But, however, the residual atmosphere is not one of pure carbonic acid, nor yet of pure nitrogen, but of a mixture of these gases, with, in most instances, a certain quantity of undecomposed atmospheric air, it is possible that by some such arrangement the atmosphere might be rendered to some extent less noxious, but whether it would be sufficiently so as to support animal life is to say the least, so problematical that it could scarcely be depended upon as a means of safety. In most cases the probability is, that after the carbonic acid had entered into combination with the lime, the nitrogen would be so much in excess as to effect by suffocation that which the carbonic acid would have effected by a different process.

The idea of refuge stalls, thrown out by Mr. Barkley, has been examined subsequently in 1832 by others who, abandoning any system of chemical action, simply propose to make these refuge stalls reservoirs of atmospheric air, to which the men could betake themselves after an accident.

Now in this proposition there are four things involved.

The first is, that these stalls should, under ordinary circumstances, be in communication with the regular system of ventilation of the mine. If they were not, they would soon become stagnant spaces in which an impure atmosphere would accumulate unfit for respiration. It would further be requisite that some mechanical device should be resorted to, whereby on the occasion of an explosion these reservoirs should separate themselves from the ordinary ventilation, and shut out from their interior the foul air. Such a self-acting mechanical arrangement might fail in its action, and the refuge stalls fill with choke damp, and so be utterly useless for the purpose they were intended for.

In the next place, these refuge stalls should be so frequent as to be of ready access to men from all parts of the workings; and lastly, they they should be of sufficient capacity to support life to their inmates until the ventilation of the mine could be restored.

Now with respect to this latter point Mr. Gurney, in his evidence before the Committee of 1832, seems to think it practicable so to construct these refuge stalls as that they should serve as a place of safety for the men for a long space of time, say 24 hours or more. None of the witnesses who spoke in favour of these refuges appear to have gone into any calculation respecting the quantity of air required to support life for a given time, and consequently their evidence is entirely deficient in a point

of the highest importance, viz., the requisite capacity of these places. In order to arrive at precise information on this point, the following calculation is submitted :—

According to Dumas, on an average a man, by respiration, transforms into carbonic acid, in one hour, all the oxygen contained in 90 litres, or $19\frac{8}{10}$ gallons of air$=3\frac{2}{10}$ cubic feet$=91\frac{1}{2}$ cubic inches per minute; but 100 parts of air, according to Thomson's experiments, performed with very great care and by means of electricity, contains 80 of nitrogen and 20 oxygen, a statement varying somewhat from the ordinarily received opinions formed on the experiments of Dalton, Davy, and others, but which is probably more correct than the ordinary statement, inasmuch as it accords with Gay Lussac's law of the union of gases in ratios the most simple, and it also agrees exactly with the specific gravity as calculated from that of the component gases and of the compound. Thus, the specific gravity of nitrogen being 972·2 and of oxygen 1111·1, we have—

$$\frac{\overset{\text{Oxygen.}}{972{\cdot}2} \times 4 \times \overset{\text{Nitrogen.}}{1111{\cdot}1}}{5} = \overset{\text{Air.}}{999{\cdot}9}$$

—the specific gravity of air; consequently 91·584 cubic inches of air contains $91{\cdot}584 \times 0{\cdot}20 = 18{\cdot}3$ cubic inches of oxygen.

Now the volume of carbonic acid produced is exactly equal to that of the oxygen consumed in its production, consequently carbonic acid produced$=18{\cdot}3$ cubic inches per minute.

Now, according to the experiments of Allan and Pepys (Phil. Trans. 1808, &c.), air is no longer respirable, *i. e.* it produces asphyxia when it contains 9 % of carbonic acid: hence, the carbonic acid generated per minute will vitiate $\frac{18{\cdot}3 \times 100}{9} = 203$ cubic inches of air, to which we must add the air from which the oxygen consumed in the production of the carbonic acid was derived, viz., $91\frac{1}{2}$ cubic inches, and we get the total quantity of air vitiated or rendered unfit for respiration, $294\frac{1}{2}$ cubic inches per minute$=10\frac{1}{2}$ cubic feet per hour. This is for respiration alone; but in addition to this, an allowance should be made for transpiration through the pores of the skin.

It is stated in Dr. Reid's Elements of Chemistry (p. 570) that the skin affects the air much in the same manner as the lungs, carbonic acid being produced and oxygen consumed. The same thing is stated in Fyffe's Elements (p. 316), who refers to the experiments of Collard de Martigny (Med. Rep. N. S. V.), but I regret I am not able to state to what extent this action takes place. Perhaps it would not be far from the truth in adding, for transpiration and vitiation from perspiration $2\frac{1}{2}$

cubic feet per hour, which will make the quantity altogether 13 cubic feet per hour. Consequently a refuge stall to hold 20 men would require 260 cubic feet per hour, or for 24 hours, 6,240 cubic feet, equal to a board 12 feet wide, 5 feet high, and 104 feet long.

The next system to which I will direct your attention, is that proposed by Mr. Hutchinson, in 1849, in his evidence before the Lords Committee (1524.)

He proposes, that in order to penetrate the noxious atmosphere, a man should carry in with him a bag of air, of which he states 4 or 5 cubic feet would last half an hour. He speaks also of a mask with a valvular arrangement, so that the expired air shall pass off direct into the atmosphere. Now this proposal is a step in the right direction, inasmuch as it renders each man to the extent of the air he takes with him independent of all general arrangements; but, in the form proposed, it would be found, from the cumbrous size of the apparatus, utterly impracticable in practice. Mr. Hutchinson seems to have miscalculated the quantity of air required, or rather to have based his calculations upon the quantity actually vitiated, to the extent of producing asphyxia, rather than upon that actually passed through the lungs, and expired in a less vitiated form.

As we pointed out before, the quantity actually rendered unfit for respiration by the lungs, is at the rate of 10½ cubic feet per hour, which agrees with Mr. H.'s estimate, but this is what would produce asphyxia in a person breathing it—uot what he would require to support him so as to be able to give active assistance to others, or repair damages in the mine, and that this is what Mr. Hutchinson means is evident since he speaks of the expired air escaping direct into the atmosphere.

The quantity of air required under these circumstances would be from 300 to 320 cubic inches per minute, and about 80 for the lamp, say in the whole 400 cubic inches per minute, or 14 cubic feet per hour.*

* *Estimate of Quantity of Air required per minute.*

For 1 Man.—According to Dr. Thompson a man inhales on an average 320 cubic inches of air per minute.

For 1 Lamp.—A Safety Lamp burns about 0·016lb. of oil per hour.

Now, oil contains in 100 parts 78 carbon, 11·5 hydrogen, 10·5 oxygen, but 6·12 carbon requires 16 oxygen.

$$\therefore \text{ 78 carbon requires } \frac{78 \times 16}{6 \cdot 12} = 204 \text{ parts of oxygen.}$$

Agaid, 11·5lb. hydrogen requires $11 \cdot 5 \times 8 = 92$ oxygen.

$\therefore$ Total oxygen required $= 204 + 92 = 296$; and deducting the 10·5 oxygen contained in the oil, there requires 285·5 oxygen for 100 of oil, or 2·855 oxygen for 1 of oil.

Now a bag to carry this quantity, or even half of it, would be by far too bulky, and would be found impracticable to use it in many cases where from falls in the roof, the passages would be much contracted.

The principle, however, is good, and it is with a strong conviction of its goodness and value that I set about devising the instrument which I now bring before you.

It is represented in Fig. 1, and consists of two parts. 1st. The reservoir containing the air, which is to serve for respiration, and which is compressed to a very high degree of tension, so as to reduce the bulk; and 2nd, of the respiratory apparatus, the object of which is as follows: The air in the reservoir being at first at a very high degree of pressure, and that pressure gradually diminishing, it is obviously necessary to provide some means whereby it may reach the lungs under a uniform and moderate pressure. This is accomplished by the regulating box, which is in fact a self-acting valve, by which the compressed air is let to escape from the reservoir.

This is represented in Section in fig. 2, and consists of two conical-shaped vessels made of tin plate, *AA* and *BB* bolted together by the flanges at *CC*. To the small end of *BB* is attached a brass valve piece *D*, which screws into the stop cock *E*, communicating with the reservoir of compressed air. The valve piece has two apertures *GG* opening into *BB*, and these apertures are opened or shut by the sliding piece *FF*.

The two conical vessels *AA* and *BB* are separated by means of a flexible diaphragm of india rubber *KK*, held between the flanges. This diaphragm is connected with *FF* by means of the spindle *H*, which is screwed into *FF*. *I* is a pipe to which is attached a flexible tube, through which the air passes to the lungs, and *L* a smaller pipe to supply the lamp if required.

The action of the apparatus is as follows:—In the first place the spindle *H* is turned until the diaphragm assumes a slightly convex form as *MM*, by which means it has a tendency to force down *FF* and open the ports *GG*. The amount of this tendency depends upon what we may

Now, 8 of oxygen is contained in 36·4 of atmospheric air.

$\therefore$ 2·855 of oxygen is contained in $\frac{36{\cdot}4 \times 2{\cdot}855}{8} = 13$ parts of air.

Consequently, 1 part of oil requires 13 parts of air, and air required per hour $= 0{\cdot}016 \times 13 = 0{\cdot}208$lb.; but 1lb. of air $= 13$ cubic feet.

$\therefore$ Air consumed per hour $= 13 \times {\cdot}208 = 2{\cdot}704$ cubic feet.

$= 77$ cubic inches per minute.

Which added to the quantity required for the men $= 400$ inches per minute.

term the working pressure in *BB*, *i. e.* the pressure at which it is desirable to bring the air to the lungs. This may be regulated with the greatest nicety, and varied at any time by simply turning the spindle *H*, so as to be either superior or inferior to the atmospheric pressure. Ordinarily the working pressure will be slightly superior to the atmospheric pressure, and in this case the diaphragm will be made slightly convex towards *AA*. So soon as the pressure in *BB* is diminished the diaphragm opens *GG*, and a fresh supply of air passes from the reservoir; but the moment the pressure in *BB* exceeds the working pressure, the diaphragm is forced towards *AA*, and shuts off the supply. By this action then a uniform degree of pressure is maintained in *BB*, whatever be the amount of pressure in the reservoir.

The rest of the apparatus consists of a flexible tube, through which the air is conveyed from the regulating chest to the mouth or nostrils, and the valvular arrangement connected therewith. In some cases it may be sufficient simply to insert the end of the pipe into the mouth, and the small nostril valves into the nostrils. These valves are perfectly simple in construction, and consist of a piece of india rubber tube closed by a flap, and admitting of expiration, but preventing inspiration. But another arrangement may be found preferable by means of which inspiration and expiration are both performed through the nose. This consists of a small valve chest with two valves, one opening inwards and the other outwards.

The one opening inwards is made of india rubber, and is stretched to such a degree that it will not open by the pressure of the regulating box, but only when the force of inspiration is added thereto. The reservoir may be slung either in front or behind, and the small pipes of the nostril valve being inserted in the nostrils, the man is ready at a moment's notice to pass with safety the deadliest combination of gases. In cases of need a small branch pipe may be attached to the safety lamp, and thus furnished, forth he may enter an atmosphere of pure carbonic acid.

But it is not only as a means of giving assistance to those below that I propose this apparatus. If it has any value it is in its portability and adaptation at a moment's notice, and I would propose that each man and each boy should each day take with him his supply of air, as he now takes with him his Davy Lamp. The apparatus would then be within reach, and in case of an explosion, might be applied at a moment's notice, and the men, the vast majority who are not burnt or injured by the concussion, might at once proceed outbye to the shaft, or even commence at once to restore the ventilation by repairing stoppings, &c. &c.

I have only further to direct your attention to the mode of filling the reservoirs with compressed air.

This may be done by an ordinary compressing or condensing syringe, or by a small hydraulic press force pump, worked either by hand or attached to the steam engine at bank. In this latter mode water would be forced into a reservoir of suitable size, to which the smaller reservoir to be filled would be attached by a screw coupling. As the water was forced in, of course the air would be expelled from the larger into the smaller reservoir, and by a proper proportion of the capacities of the two, and the size of the pump, any required degree of pressure might be attained. But the system which I would recommend as at once the simplest and most effective, is the following:—

In some convenient place at the bottom of the shaft I would place a hydraulic press with two cylinders, one directly above the other and firmly connected to it, and a double ram, Fig. 3. The area of ram in the lower cylinder *A* would be to that in *B*, as pressure arising from a column of water equal to the depth of the shaft to the pressure to which the air was to be compressed, with an allowance of course to overcome the friction of the ram. To the lower cylinder *A* is connected a small pipe, say of 1½ in. diameter, leading to a cistern of water at the top of the shaft, and to the other cylinder *B* another small pipe leading to bank, to bring down the pure air. Each of these pipes is furnished with a cock or valve, as *E* and *F*. The cylinder *A* is provided with another cock *G*. To the top of the cylinder *B* is screwed the small reservoir, which is to be filled with compressed air, provided with its own stop cock. The action of the apparatus is very simple, the cocks *F* and *G* being shut, and *E* open. The column of water in the pipe *E* enters *A*, and forces up the ram *A*, and with it the ram *B*, driving all the air in *B* into the small reservoir. The cock *E* is then shut and *F* and *G* opened, when the water escaping by *G*, the ram descends by its own weight, and *B* is again filled with fresh air from bank, through the pipe *F*. This process is repeated until the required quantity of air is forced into the small reservoir, when it is removed, and another similar vessel takes its place until the whole are filled.

I would further propose to have another pipe *I*, with its stop cock leading from *B* to a large reservoir, Fig. 4, which should be kept constantly full of compressed air. The object of this reservoir is two-fold. 1st. That there might always be a supply to fall back upon in case of emergency; and secondly, that each man's reservoir being daily applied to it as he goes to work in the morning, he may be sure of his taking it with him charged at the proper pressure.

Mining Engineering of which they had so many opportunities of availing themselves, and, on the other hand, the Institute might reciprocate those services. The President then proposed Baron Von Humboldt; Aberbergrath Von Carnall, Mining Inspector, Berlin; M. De Vaux, Inspector General of Mines, Brussels; Mons. Gonôt, Engineer in Chief, Belgium; M. De Boureuielle, Director General of Mines, Berlin; M. Von Decken, President of the Royal Superior Mining Court, Bonn; as honorary members of the Institute, which resolution was adopted unanimously.

The following gentlemen were elected ordinary members, Messrs. J. P. Baker, H. S. Stobart, Rawling Stott, A. Watney, A. Homfray, and Thos. Walker, Jun.

The PRESIDENT remarked, with reference to the minute of the Council respecting the printing and revising of papers, that considerable delay had taken place in consequence of its being thought necessary to send a copy of the printed report to every member who had taken a part in the discussion. The Council had arranged to lay the papers on the table of the Institute on the Saturday, and he trusted those members who took part in the discussion thereon, and felt anxious to revise their speeches before they were printed, would avail themselves of the opportunity thus afforded them. It was very desirable to encourage free discussion; but, as matters irrelevant to the subject under consideration were sometimes introduced, it was desirable to curtail such obvervations in the printed reports. He hoped the members would have confidence in himself and Mr. Taylor that nothing was omitted which ought to be inserted, and the members would have an opportunity of supplying any omission which they may have themselves made.

The arrangement appeared to give general satisfaction.

The PRESIDENT said the next subject he had to introduce was the establishing of a Mining School. He had already had the honour of bringing that subject before the members of the Institute, on more than one occasion, and he was quite sure it was unnecessary for him now to trouble them with any observations as to the necessity of such an Institution. Indeed, he thought, it would be admitted by every one that a Mining School in this district was almost essential to the proper education of those who would in future have the management of our mines. Other classes had schools for promoting education, and he thought it highly desirable that miners and managers of mines should keep pace with other parties in that respect. They would have observed that in Cornwall a Mining School was about to be established; it had long been a subject

of discussion there, but it was now being carried into execution. They had first of all appointed a Committee to go into the question and draw up rules. The report of that Committee had been drawn up and laid before the general body; and it was now being printed; and, as far as he understood, there was not the least doubt of the recommendations of that Committee being carried into full effect. This district had always been looked upon as a proper place for a College or Mining School, and, perhaps, very properly so, for they had opportunities of gaining information and experience here which were not enjoyed by other places. It was only necessary, therefore, for them to put their shoulders to the wheel in order to carry out the object successfully. Mining was every day becoming more difficult. In all districts of the country they found mines being sunk deeper and deeper down, and new difficulties were in consequence met with. And, as most of them knew, other districts were drafting away from this man after man, to take the management of their mines; and he believed, at this moment, there was a scarcity of properly educated persons to take the management of mines in this district. It was, therefore, absolutely necessary that education should be extended in regard to mining beyond what had been hitherto done. They ought to have a sufficient number of educated men, not only at present, but hereafter; and they also required to have persons of a higher grade of education. Indeed, he thought it almost unnecessary to make these observations, because every one there must be convinced from their own experience, not only of the desirability of establishing a Mining School, but that this was the proper district for commencing one in. It had been stated to them, on former occasions, that attempts had been made to unite the two Medical Schools in this town, and by co-operation with the University of Durham, to establish a Mining School or College here. He believed every pains had been taken to unite these two bodies, but, he regretted to say, unsuccessfully; and it was now deemed by every one that it was quite impossible to bring about an amalgamation between those two parties. The Durham University had always come forward in the most handsome and liberal manner. The worthy Warden had always stated that he was quite prepared to do anything towards the establishing of a Mining School in this district, and the promotion of mining science in general. Therefore, he thought it was only necessary for them to commence, in order to ensure their being supported by the University of Durham. They were also certain of being supported by the Central Institution in London, having had Professor Playfair's explanation of his views upon the subject, who expressed the willingness of that Institution

to do every thing in their power to promote the establishment of a Mining College in Newcastle. He was quite sure also, from what took place in Parliament last session with respect to the inquiry into accidents in mines, that something of the kind will be recommended by the Committee, which is to be renewed this session. He thought, without assuming more than belonged to them, as having peculiar opportunities of acquiring and imparting sound practical information, which in fact no class of miners in the country had but themselves, that they were the proper persons to commence such an undertaking; and he believed if it were only begun it would form a nucleus for the principal mining, chemical, and manufacturing interests of the district, to support and carry out the object successfully. The coalowners, proprietors of chemical works, manufacturers of various kinds, and Mechanics' Institutions would, he felt assured, rally round them, and they would, he trusted, establish an Institution which would not only do credit to their Institute, but also benefit the neighbourhood and mining at large. With these observations he would take the liberty of laying before them a resolution which had already met with the sanction of the Council:—"That this meeting is of opinion that the time has arrived when it is essentially necessary that a Mining School and College of Practical Science should be established in this district; that this Institute appears to be the most suitable body to take the initiative in such an object; and that the Council be requested to consider and report to the Institute the necessary preliminary steps to be taken towards the establishment of such an Institution." If they approved of this resolution, the Council would go fully into the subject. They would enquire what sort of College and School would best answer the purposes intended, under what arrangements it was desirable to establish it, and they would prepare a report upon the subject, to be submitted to the consideration of the members of the Institute at the earliest possible period. Although the resolution laid most stress upon a Mining School, it was obvious such an establishment would comprise science in general, so as to make it both useful and popular. Before putting the resolution to the meeting, he should be glad to hear any observations upon the subject from any of the members.

Mr. M. Dunn—The resolution only empowered the Council to inquire into the subject, and report to a subsequent meeting of the Institute.

The President—That is all. The subject will then come fully before the Institute.

Mr. Barkus said he thought there might be considerable difficulty in carrying the matter out, as he considered it might involve a degree of

responsibility which this Institute did not contemplate at its commencement. He should like to know what sort of responsibility the members of the Institute would be called upon to bear.

The PRESIDENT said all these details would be explained when the Council went into the subject. He did not apprehend that the funds of the Institute would be at all involved in supporting such a School; for he trusted they would get support for such an undertaking. No doubt as individuals they were all interested in carrying the object out, and would contribute their mite towards it. As to difficulties, he never thought them insurmountable. They might have to deal with some difficulties no doubt, but he did not think they ought to be deterred from the pursuit of this object by imaginary difficulties. If they made the attempt, he had no doubt they would have the support of all the mining interests of the district, and elsewhere. While upon the Continent recently he had heard very strong opinions expressed with respect to the great utility of a School of the kind in this district, where so much practical knowledge could be obtained. He should be happy to hear any further observations.

Mr. TAYLOR said the proper time to discuss the subject would be when the report of the Council was laid before them, and they were in possession of all the information obtained by inquiry.

Mr. REID then proposed the adoption of the resolution submitted by the President.

Mr. LONGRIDGE seconded the motion, and it was carried unanimously.

The PRESIDENT said the next business would be, to take the discussion upon Safety Lamps, Mr. Hall's Improvements in Colliery Workings, and Mr. Greenwell's paper on Ventilating Dip and Rise Workings. Mr. Mackworth, who had been unable to attend, had sent a letter containing some observations on Safety Lamps, which the Secretary would read. As Mr. Hall and Mr. Greenwell were not present, perhaps the discussion on their papers might stand over.

The SECRETARY then read the following letter from Mr. Mackworth :—

January 28th, 1854.

MY DEAR SIR,

As I am unable to attend the discussion at the Institute, I am anxious to state my views as to the employment of Safety Lamps. The experiments lately made by the President and by Mr. T. J. Taylor afford an agreeable relief to the quackery so often paraded, of exploding through lamps

by means of a pencil of gas forced upon the gauze, and whilst they satisfy us that, what Sir H. Davy long ago told us, respecting the passage of flame at high velocities, is correct, they show that this limit of safety is preceded by so great an intensity of heat, that the practice of mining is hardly likely to offer an example of such a contingency.

The safety of the common lamp is sufficiently shown by there being, in the 38 years of actual trial, no well authenticated instance of an explosion being caused by a safety lamp. In the three coal-producing countries of the Continent, by common consent, the exclusion of exposed flame from fire-damp mines has passed into a law, and not a doubt is entertained of the safety of the Davy, which, with the exception of about 8,000 Mueseler Lamps, in mines near Liege, is the one universally used.

The explosions in those countries, which are not half as many as in ours in proportion, arise either in mines where the presence of fire-damp had not previously been ascertained, or by the opening of a locked lamp; not in any case by the fault of the principle of the Davy. It is high time that reprobation should fall on the attempts of certain empiricists, who, by denying its safety, under the guise of humanity, are flaunting in a transient popularity, but who are prolonging the annual sacrifice of several hundred lives; inasmuch as they divert the public attention from the point to which we must some day come—of excluding exposed flame from every part of a fire-damp mine.

Mr. Taylor explains the signal immensity from explosions effected by the safety lamp in pillar-workings, which are so dangerous that they cannot be worked without them; and he shows how very little more is required to place the Northern Mines entirely under lamps. But with me it is not a question, so much how the best of your northern mines are lighted; my attention is directed to the condition of the great mass of other coal mines, and the reckless system adopted. The 1,000 fire-damp mines which contribute the great majority of victims, are almost always overlooked in the discussion, for the sake of the 50 which take the lead.

The unerring test of practice has decided the safety at least of the Davy, Stephenson, and Mueseler; let them only be completely adopted. In the average condition of mines the mixed system of lighting, the want of discipline, and the many short-comings, place us far below the point where the question of the safety of the principle of these lamps ought to arise. It is not a question of safety in the abstract, or Glover's, Hall's, and other more perfect lamps would be adopted.

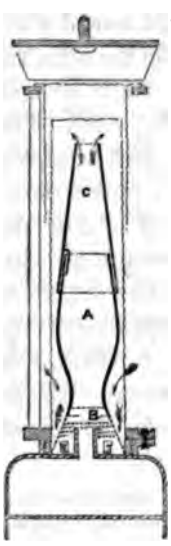
The real questions in practice are the locking, the amount of light, the

extinction in an explosive mixture, the value as a test for gas, the effect of ill-usage, the prevention of smoking, and others of a similar kind.

The Davy is without a rival for testing the presence of gas, and is therefore especially suitable for the deputies, but it must be recollected, that unless the flame is diminished before using it as a test, it will not show a halo, and yet a collier by unscrewing his lamp at that spot, may cause an explosion.

The Mueseler, which is little more than the Clanny with a metal chimney in it, gives more light than the Davy, and goes out at once in an explosive mixture. Like Glover's lamp, the air enters by a double gauze, descends near the inside of the glass so as to keep it cooler than in Clanny's, and the long metal chimney is more decisive in its action than that in Glover's. At the Grand Bac Mine, near Liege, I found 400 Mueseler's in constant use, and the breakage of glasses was from 1 to 4 per week, but a piece was hardly ever broken out of the glass.

In June last year, I brought before the Committee on Coal Mines, an improvement in safety lamps, which I afterwards submitted to the Institute in September, and which was contrived to meet comparatively frivolous objections which were made to me in my endeavour to get locked safety lamps universally adopted. I have avoided interfering with the practical reputation of the three lamps in use, and endeavoured, by an addition of a simple kind, at very small cost, and capable of fitting any lamps in use to increase the light and obviate some of the defects which arise from the habits of colliers.

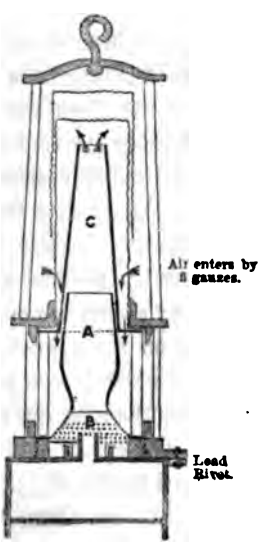


Sections of Davy's and Clanny's Lamps showing the addition of Safety Tubes and mode of Locking by a Leaden Rivet.

The improvements are shown in strong lines.

Iron Wire gauze 1000 holes to sq. in.

Scale—one half full size.



To the ordinary Davy, Clanny, and Stephenson I have added a chimney. This chimney *A*, as shown in the sketch, is of glass, contracted near the bottom to improve the combustion. It is mounted on a cone of perforated copper or gauze *B*, so that the air has to enter through a double gauze. On the top of the chimney is a long tapering cap of copper *C*, which, without diminishing the light, contracts the outlet, so that only the slightly cooled products of combustion pass, and it acts like a gauze in checking the passing of an explosion upwards. I have adapted a very similar contrivance to the Mueseler, and in which the air has therefore to enter necessarily through three gauzes, and to pass out through the chimney and two gauzes. The light is in all the lamps nearly doubled. My object has been, at a cost of 6d., to put *one safety lamp inside another*. It will fit any lamp, and can be made by the lamp-cleaner at any colliery.

The effect will be to prevent danger in case the glass of the Mueseler breaks, to obviate the risk arising from dirty lamps, and to prevent any tampering with the flame.

The locking of the lamps is, in my opinion, the most important subject connected with safety lamps. My observations of the causes of explosions tend to show that the use of unlocked lamps, or the partial lighting with candles in a colliery, is more dangerous than when exposed lights alone are used. Where lamps are nominally locked by the common screw, the men can unlock them whenever they wish to do so, and in some instances I have found the majority of the lamps having the hole of the screw rimed out from the frequency of the practice. To remedy this evil practice (one of great frequency and importance), I have tried several plans. One is, the locking by a long key passing up the pillar of the lamp, and made of this length, so that if a false key were made, it might be more easily detected on the person of the offender. The lamp which I have sent showing this improvement also has a circular wick, which is raised or lowered by simply turning the gauze. Another plan is, a padlock brazed to the oil-box, with the key-hole downwards to clear it of dust; but this too can be picked. The other lamp which I have sent to the Institute, exhibits the first attempt at a method of locking which at once detects any attempt to open it. It consists of a lead rivet passing through cheeks on the upper and lower part of the lamp. It is clinched by nippers, which leave a letter or die-mark on the end of the rivet. To open the lamp the rivet can be cut across the middle with a knife, and then the two ends drop out.

I need hardly say, that as my object is to simplify and remove some of

the difficulties in arriving at a more perfect system of lighting collieries, that any of these suggestions are at the service of any one who chooses to apply them.

I remain,

Yours very truly,

EDW. SINCLAIR, ESQ. HERBERT MACKWORTH.

A Lamp, with the adaptation recommended by Mr. Mackworth, was exhibited.

Mr. TAYLOR remarked that it appeared complicated, and not calculated to give a better light than the ordinary Davy.

The PRESIDENT said he certainly felt his mind very much relieved by the experiments which he had made upon Safety Lamps. He was much more satisfied as to their safety than he was before. In these experiments he found that when the flame passed the gauze it did so under circumstances which never ought to occur in practice. He felt quite satisfied that with ordinary care the lamps used in mines here were perfectly safe. He thought the Davy Lamp, if properly used, and if taken out of the mixture of explosive gases without putting it into a great velocity so as to increase the temperature beyond a certain point, would not pass the flame. It was certainly of importance to know under what circumstances the flame would pass, so that they might guard against it. With Stephenson's Lamp, which was protected by glass, no such circumstances could occur, and he therefore thought that Lamp an exceedingly safe one. As long as the glass remained whole, the gas would not affect the intensity of the flame beyond a certain degree, when it would be extinguished; and, if the glass broke, it simply became a Davy Lamp, and they knew under what circumstances it would explode. In practice the heat of the flame never could become so intense as to cause an explosion. It ought to be observed, however, that the shield was no preventive against explosion. It was only about two inches high, and could not prevent explosion under the circumstances elicited by his experiments; therefore, they ought not to depend upon the shield as a preventive under these circumstances. In ordinary practice no case could occur wherein the intensity of the flame would become so great as to cause an explosion.

Mr. DUNN—The inventive genius of the country was now alive upon this subject, and it ought to be allowed to run on, without this Society pronouncing in favour of any particular lamp. It was probable that some new invention might come out before the next meeting after such

an opinion had been pronounced. It was therefore desirable to let the progress of improvement go on, and they could select out of the many inventions brought forward that which might be best adapted for the particular circumstances of the mine.

The PRESIDENT—You are quite right. This is an age of progress, and it is desirable it should be promoted.

Mr. TAYLOR—Adverting to Mr. Dunn's view of the subject, it might still be thought desirable to give a little direction to the inventive genius of the country. They might assume, from recent experiments, that practically speaking, the Davy was a safe lamp; but, at the same time, he was afraid they must also admit that the Davy Lamp did not give a sufficient degree of light. If they could get a lamp to combine the safety of the Davy with a greater degree of light, it would no doubt be very beneficial.

Mr. DUNN thought Mr. Mackworth had admitted in his paper that many accidents occurred in mines under the use of the Davy Lamp. The contrary, he believed, was the fact.

Mr. TAYLOR said he believed there was not one authenticated instance of an explosion having occurred under the use of the Davy Lamp. He had investigated the subject very carefully, and had come to that conclusion.

Mr. SINCLAIR—Mr. Mackworth states the same in his paper.

Mr. TAYLOR—It mentions the instances of broken lamp glasses occurring as from one to four weekly; if you multiply that by the number of weeks in a year, it will give about say 200.

Mr. SINCLAIR—But in all these cases the glass was not broken, they were merely cracked.

Mr. TAYLOR—Does Mr. Mackworth say so distinctly?

Mr. SINCLAIR—Yes. He says "out of more than 200 lamps, a piece was hardly ever broken out of the glass."

Mr. TAYLOR thought it worthy of consideration whether much finer gauze than that commonly used might not be introduced. When Davy invented his lamp, the manufacture of wire gauze was not so perfect as it was at present. With a greater number of apertures, the quantity of light would be materially increased.

The PRESIDENT—The only question would be as to the gauze being sufficiently strong.

Mr. TAYLOR—Yes.

Mr. SOUTHERON, Jun., observed, with respect to the locking of the lamps, that the principle suggested by Mr. Mackworth had been adopted

in the Stephenson Lamp in those recently constructed, and was found to be of very great value.

The PRESIDENT next called attention to the other subjects of discussion. In reference to Mr. Greenwell's paper on the Ventilation of Rise and Dip Workings, Mr. THOS. JOHN TAYLOR explained, by means of a diagram, the difference of resistance at various points in coursing the air through the workings of a mine. The general result was, that both in rise and dip workings, as well as those on the level, irrespective of temperature, there was a difference of resistance, *the column of air entering the working being more compressed, and consequently denser, than that passing out.* In working to the dip the light air had its natural tendency to ascend in the return unimpeded; but in working to the rise the contrary was the case, the light air having to be driven downwards before it passed into the upcast shaft.—After some general discussion upon the subject, Mr. Taylor promised to resume it at a future meeting.

The SECRETARY then read a paper "On Boring," by Mr. H. Mackworth. Papers "On Water as a Ventilating Power," and "On Coal Cutting by a Machine," a model of which was exhibited, were also submitted to the Institute.

The President having retired, the chair was taken by Mr. Thos. John Taylor, who presided during the remainder of the proceedings.

IMPROVEMENTS IN BORING

FOR

MINERALS, WELLS, AND SHAFTS.

Our President having invited communications from Members of the Institute, on various subjects intimately associated with Mining, amongst which he enumerated Boring, I have endeavoured to draw a practical comparison of the relative merits of the various systems employed on the Continent, with the view of submitting to the notice of the Institute, the success which has attended the system and operations of Mr. Kind.

It is surprising in this country, the richest in the world in present available mineral wealth, and where the beds of mineral, faintly sketched in their subterranean depths by the researches of the Geologist, are for a large portion covered up by unconformable rocks, that so little attempt has been made to improve, and raise into a science, the practice of boring, whether it be to ascertain the position and quality of Coal, Ironstone, Slate, Gypsum, Salt or Mineral Lodes, to obtain Gas as in China, Salt or Medicinal Springs in their appropriate rocks, to intercept the drainage of geological basins by Artesian Wells, to bring up water from great depths of a natural temperature, sufficient for public baths, without the intervention of fuel, or simply to inform a landed proprietor of the value of his estate in depth, in the same way as his map does of its superficial extent. In all these respects, we are thrown every year still more on the art of the Borer, by which we see through the Earth's crust, and

certify the existence of those new sources of wealth which science has taught us to expect.

There are few departments of Engineering towards which so many paths of science tend; there are few operations of a mechanical kind which require the union of so much ingenuity, patient observation, and unflinching perseverance combined; and yet, notwithstanding the practical skill and mechanical capabilities of which we boast, we are, in the practice of boring, allowing the continental Engineers very much to surpass us.

Towards the close of the last century, James Ryan patented a method of extracting by boring lumps of rock as specimens; and several other patents have followed, such as that of J. Good in 1823, for improvements in the tools; yet little improvement has been made in boring in England. In France and Germany, since the time of Bernard Palissy, until 30 years ago, the progress was also insignificant. Since then, the talent and ingenuity of D'Oeynhausen, Degousée, Kind, and others have met with well-earned success, and have rendered the operation of boring more effective, rapid, economical, and certain in its results.

The multiplication of Artesian Wells, which are said, in the majority of instances, to return double the capital expended, has aided in improving the art, and led to the carrying out of much larger and deeper borings. The well at the Abattoir of Grenelle is 600 yards in depth; the boring to the Salt Spring at Mondorff, executed by Kind, is 764 yards deep. Similar borings near Brunswick reach to 566 and 626 yards, and at Minden to 742 yards.

Boring can conveniently be classed under five systems.

The Abbé Imbert relates, that he had seen in China, holes bored from 5 to 6 inches in diameter, to a depth of 5 or 600 yards, at a cost of from 400 to £500.

The Chinese system consists in suspending the tool by a rope wound on a drum, by which the tool is alternately raised and dropped, and it acts solely by percussion. The shank of the chisel consists of a heavy iron cylinder, and the torsion of the rope is sufficient to turn the chisel after each shock. This system has been several times employed in England. At Ardwick, near Manchester, holes of considerable size, from 3 to 4 feet in diameter, were sunk by it. It has been employed and improved by Jobard & Sellignе; and at Sarrebruck Mr. Sello, the Director of the Government Coal Works, has bored numerous air-holes of a foot in diameter, during the progress of the coal-workings, for ventilating the drifts and removing the fire-damp.

The principal objection to the system, lies in the difficulty of boring through hard strata having a considerable dip, or straight enough to admit of the insertion of tubes in soft ground.

The English or German system, which is too well known to need a detailed description, consists of a continuous series of iron rods jointed or screwed together, and carrying various tools, which are made to penetrate the strata either by a circular motion or by percussion. Although for yielding ground it may be sometimes convenient to use wimbles and similar tools, in hard quartzose sands and all kinds of rocks, the system of percussion is alone applicable.

The objection to the continuous iron rods is well stated by M. Degousée:—

"When the borings are very deep, the weight of the rods prevents "the Borer acting by percussion, and yet there is no other means of pe-"netrating hard rocks; the instrument therefore runs the risk of break-"ing frequently. Besides, to act by percussion, the instrument raised "from 3 to 4 inches, and then allowed to fall, is subject to a tremulous "motion between each shock, which lashes it violently against the sur-"faces of the bore-hole; this tremulous motion repeated from 12 to "15,000 times a day, and during many months, entails the deterioration "of the retaining tubes; and if the bore-hole is not tubed, makes the "hole oval in tender portions, giving rise to crumbling in; and the frag-"ments occasionally press angularly against the tool in such a manner "that the rods break by the efforts necessary to extract them."

To obviate this objection to some extent, D'Oeynhausen's Slide has been extensively used on the Continent. It is inserted at a height of 5 or 6 lengths of rods above the tools, so that it confines the shock of the fall to that portion. By means of a strong spring, or counter-balancing the upper lengths of the rods, this portion has simply to support the weight of the lower; and is generally made of lighter materials, frequently of wood with iron ferules and screws.

The third system, that of the Société Freminville, presents many ingenious contrivances, and every care has been given to bring the principle on which it is founded, to the utmost perfection of which it was capable.

It consists chiefly of an improvement on the Chinese method. The entire depth of the hole is tubed, the tubes being kept loose by turning, so as to descend as the boring proceeds. A pile chisel works in grooves at the lower end of the tube. After a certain depth has been bored by percussion, a forked tool, with saws at the extremities, which are forced

outwards by a ring, enlarges the hole to a size sufficient for the descent of the tube.

The system of Monsieur Fauvelle, which next calls for notice, possesses a high degree of novelty and ingenuity. The removal of the chisel to allow of the bore-hole being cleared, is unnecessary, as by means of a rapid current of water, the debris are brought up to the surface as soon as formed. The tube in this instance, screwed together, forms the rod, and extends to the bottom of the hole, but is considerably smaller than the hole in diameter. A great advantage is also gained in the continuous clearing of the surface acted on by the chisel. Ordinarily the current of water is forced to descend the inside of the tube, whilst the debris are brought up by the current on the outside; but when passing through gravel or rock, it is found necessary to force the current up the tube. In this manner stones of 2½ inches by 1¼ inches in size have been brought up by the current.

At Perpignan, according to Mr. Arago, in July, 1846, a boring was made by this system to a spring at a depth of 186 yards, in 23 days, or 140 hours of actual work. A boring at the same place, undertaken by another person, occupied 11 months in arriving at the same depth.

The action of underground currents, and the absorption of water by certain strata, as well as the difficulties presented in deeper borings, have operated against its general adoption, however extraordinary may be the result in some grounds and in shallow borings, under fortunate circumstances.

The fifth system, which I think especially deserves the attention of the "borer," as offering a solution to most of the difficulties and imperfections of this work, which has been uniformly successful in a great number of instances during the last nine years, and is very extensively at work on the Continent, is that of Mr. Kind. The three improvements which I shall have specially to mention, are the use of light rods, boring with a "*free fall*" percussion tool, and the method of ascertaining, with the precision usually attained by a shaft, the exact nature and dip of the ground bored through.

At Besch, in Luxembourg, Mr. Kind first used the light wooden rods, and a depth of 290 yards was bored in seven months, at a cost of £320. The next work to which the apparatus was applied, was the deep boring for salt at Mondorff. During the progress of this work, Mr. Kind invented the free falling tool, and in July, 1844, it was applied at a depth of 371 yards. The work had, up to that time, occupied 37 months, and cost, including tubing to a depth of 291 yards, the sum of £1,873. The

lower portion, 323 yards in depth, was executed in 14 months, at a cost of £829.

The "free fall" of the tool, with a length of rod attached to it, effects in a more perfect manner the object of D'Oeynhausen's slide, in removing from the wooden rods the injurious vibrations caused by the shock of the tool.

The mode of action is explained by Figs. 1 and 2; the first showing the manner in which the upper end of the piece *(A B)* is taken hold of by means of the fangs *(C D)*, which work on the centres *(E)*; the latter figure exhibiting the position of the various parts at the moment the tool is released. The tool is not shown, it is screwed into the bottom of *(A B)*. The fangs are made to bite by means of the ring and wedge *(I)* being forced downwards. As this ring *(I)* is drawn up, it immediately opens the fangs. The ring and wedge are attached to a leather piston *(K)*, made about half an inch less in diameter than the bore-hole. The rods are moved up and down in the usual way. At the end of the upward stroke, a sudden motion is communicated in the opposite direction; this causes the pressure of the water against the under side of the piston to lift the ring, and open the fangs. The tool falls, and the rods follow at a slower speed. Having descended to the proper point, a slight upward motion, producing pressure against the upper side of the piston, causes it to descend with the arm and ring, and close the fangs. The tool is then lifted to its position for the second fall. I saw the system in operation at Stiring, Creuzot, and Denain. The fall was from 1 to 3 feet; the number of strokes per minute, with manual labour, from 8 to 16, which can be increased, by the application of machinery, to 20 or 25. The weight of the falling tool was from 8 to 10 cwt. The holes were 12 inches in diameter. The rods are about 45 feet in length, made of wood, 3 inches in diameter, with iron male and female screws to unite them. At Creuzot the boring was expected to reach the coal through the lias and triassic series of rocks, at a depth of 500 yards. The progress had been 31 yards in the 13 days preceding, which was considered satisfactory, as the ground required tubing, although intersected by hard layers of rock. At Denain the hole had been sunk 66 yards in six weeks, through similar ground.

A boring at Hesse Homburg, is intended to obtain water of a temperature suitable for hot baths, at a depth of 770 yards. It had attained, in September last, a depth of 570 yards. At Schöningen, in Brunswick, a boring for salt springs, 626 yards in depth, was lately executed at a cost of £1,500.

Appendix No. 1 contains the particulars of 10 bore-holes in the carboniferous and later rocks, excluding the cost of installation, smith's shop, and carriage of materials.

The ordinary prices charged in England for boring holes of small diameter, without tubes, are—

			£.	s.	d.
For the first	100 yards	.....	80	0	0
second	do.	.....	230	0	0
third	do.	.....	380	0	0
fourth	do.	.....	530	0	0
fifth	do.	.....	780	0	0
sixth	do.	.....	830	0	0

the cost for the first three 100 yards being £690, or £2 6s. per yard; and for the lower 300 yards, £2,040, or £6 16s. per yard.

Degousée estimates that a boring on his own system, 655 yards in depth, will cost, in easy ground, like chalk, £6,340; in the beds of the secondary formations for obtaining coal or rock salt, £10,200; and in ground offering the greatest difficulty, £13,980. I am informed that four 8-inch borings at Salens Jura, in the same lias and marls as those of Kind, but executed by Degousée, were of the depths of 265, 270, 257, and 205 yards, and cost on an average £4 6s. 8d. per yard.

He contracted to execute an artesian well at Rouen, 360 yards deep, for £1,600, defraying every expense. M. Degousée has constructed artesian wells in other parts of France, averaging 275 yards deep, at a cost of from £600 to £1,000.

The artesian well at Grenelle, including the whole expenses and constructions over the well, cost £14,500. This was executed by Monsieur Mullot, as well as a boring at Montreuil sous Laon, varying from 10 inches to 4¾-inch in diameter, through sandy clays, hard and soft chalk marls, to a depth of 332 yards, which cost £2,080.

From these figures it will be seen that the free fall system can justly lay claim to great advantages, both in cost, time, and the magnitude of the bore-hole. In appendix 2 will be found an abstract of the register of borings executed by Kind at Kreutzberg, Moselle, in which some unusual accidents occurred.

There remains for me now to describe the mode adopted by Mr. Kind to detach cores 10 inches in diameter, and upwards of two feet in length, from the bottom of the bore-hole, so as to exhibit, with the utmost accuracy, the quality of stone passed through, the direction and amount of dip, and the actual thickness of the bed of rock or mineral. Evrard and Souich had early contrived a mode of making a cut with the boring

chisel in the line of the meridian, and then breaking out a piece of rock containing the mark.

Another method by which the direction and amount of dip could be known, depended on the meeting with a bed of soft shale, overlying one of hard rock. The shale was carefully scraped away. The position was ascertained in which the chisel stood the highest, and the amount of subsidence which occurred when it was moved at right angles to that position, was carefully noted. The first position of the tool was the line of dip, and the fall alluded to was the amount of dip in a length equal to half the diameter of the hole.

The tools used by Mr. Kind for cutting and extracting cores are represented in figure 3. The first is a crown borer, which, being armed with five chisels, by percussion, makes a circular cut to the required depth. The second tool is then lowered down to the bottom of the core thus formed, and the curved teeth slide down the surface of the core. The interior cylinder, which had previously been suspended by a cord, is then lowered so as to press the teeth inwards; a few vertical motions are given to the rods by which the teeth groove themselves into the core, and then by a jerk the core is detached, and brought carefully to the surface.

I obtained some specimens of the cores whilst abroad last year, and have sent them to the Institute for inspection. I found at that time that Mr. Kind had taken out a patent for England, and he has since appointed an Engineer, Mr. Wall, in this country, as his representative.

Several other improvements were progressing under his direction at Stiring (Moselle), amongst which were shaft borings. A shaft, 14 feet in diameter, had been bored by a tool similar to that represented in figure 4, 100 yards in depth, in about nine months, by the aid of two steam engines of 12 horse power, through the new red sandstone. The principal object was to save the erection of a 300 horse power engine, which would have been required to keep the pit dry. But as these attempts may still be classed as experimental, and I have already trespassed beyond the limits I had originally intended, I must conclude this sketch of a system of boring, which appears to fill up a void hitherto existing in mining practice, whether it is used for taking an accurate vertical section of the whole of the strata in a mineral property, for ascertaining the beds of minerals lying under a working shaft, and assisting in its sinking, or for executing large and deep Artesian Wells.

HERBERT MACKWORTH.

APPENDIX No. 1.

Abstract of Registers of Borings on Kind's System.

Localities.	Diameter of Bore.	Depth in Yards.	Time in Days of 12 hours.	Cost of labour and material per yard.	Cost of the Boring.	Nature of the Rocks.	Observations.
	Inches.			£. s. d.	£. s.		
At Montmorot Jura, No. 1	12	164	84	0 19 8	160 10	Shifting sand and gravel, 32 yds., bas marls, 43 yds., gypsums, 66 yds., saliferous, 22 yds.	Without cost of installation, and carriage of tools, &c.
Do. No. 2	do.	185	112	1 2 0	203 12	Do.	
Do. No. 3	do.	309	in progress.				
At Stiring Moselle, No. 1	do.	327	354	0 19 1	311 11	N. red sandstone, 88 yds., carbfs. grits & shales, 131 yds., coal measures, 108 yds.	
Do. No. 2	do.	355	422	1 0 11	372 5	Do.	Employing a small engine and attendant.
Do. No. 3	do.	295	330	0 19 8	289 11	Do.	
Do. No. 4	ft. in. 4 0½	120	216	1 4 4	146 0	Do.	
At Guines Pas de Calais.....	12 In.	263	86	1 1 9	285 17	White chalk, 100 yds., hard grey chalk, 163 yds.	Without cost of installation, but including tubing.
At Vizernes Do.	12 In.	159	37	1 0 7	164 0		
Boring 764 yards deep.							
At Mondorff, Grand Duchy of Luxembourg, by old system	10 In.	371	37 mon.	5 1 0	1873 0	Chalk, 46 yds., white grit, 14 yds., keuper, chalk, and gypsum, 86 yds.	
At Mondorff, Grand Duchy of Luxembourg, by new system	10 In.	393	14 mon.	2 2 0	829 0	Gypsum, 35 yds., red marls, 87 yds., quartz grit and red sandstone, 292 yds.	

APPENDIX No. 2.

Abstract of Register of Boring at Kreutsberg, near Forbach (Moselle.)

Diameter of hole 11·8 inches.

DATE.	No. of Days of 12 hours.	Depth bored.	Mean depth bored per 12 hours.	Total depth of the boring.	NATURE OF GROUND.	REMARKS.
1852.		Yards.	Yards.	Yards.		
May 1st to May 11th,	..	7·63	....	....	New Red Sandstone, ...	
June 1st „ June 4th,	3	3·20	1·07	10·83	.....	
„ 4th „ „ 17th,	24	42·14	1·75	52·97	.....	
„ 17th „ „ 20th,	6	13·53	2·26	66·50	.....	Using the free-falling Instrument.
„ 20th „ „ 29th,	17	36·40	2·26	104·90	.....	
„ 29th „ July 26th,	50	63·79	1·27	168·69	.....	
July 26th „ Aug. 11th,	29	30·65	1·06	199·34	.....	
Aug. 11th „ „ 12th,	3	3·25	....	202·59	Hard Blue Sandstone, ...	
„ 12th „ „ 19th,	13	3·36	....	205·95	Red Sandstone, ...	The Instrument not acting well.
„ 19th „ „ 21st,	4	....	....	....	Alternating with Shale,.....	Boring with Diamond Tool.
„ 21st „ Sept. 7th,	31	10·63	0·34	216·68	.....	
Sept. 7th „ „ 11th,	8	....	....	....	.....	Cleaning out the hole.
„ 11th „ „ 17th,	12	2·66	....	219·25	.....	Two pieces of the chisel left at bottom of hole, and afterwards five pieces.
„ 17th „ Oct. 5th,	32	0·33	....	219·58	.....	In consequence of not succeeding in raising these pieces, determined to bore forward. [& Sheds.
5th,	1	....	....	....	.....	A storm overturned and destroyed the Bore-house
Oct. 5th „ „ 20th,	15	....	....	....	.....	Re-erecting Bore-house, &c.—doing repairs.
„ 20th „ „ 23rd,	7	....	....	....	.....	With Diamond Tool.
„ 24th „ Nov. 2nd,	16	7·54	0·47	227·12	.....	
Nov. 2nd „ „ 16th,	25	19.12	0·76	240·24	Grey Sandstone, with Red Clay,	
„ 16th „ „ 28th,	23	14·38	0·62	260·62	Coal Shale, ...	
„ 28th „ Dec. 8th,	20	10·49	0·52	271·11	Sandstone, ...	
Dec. 8th „ „ 25th,	34	21·72	0·64	292·83	Shale, ...	
„ 26th „ „ 31st,	11	3·13	0·29	295·96	Sandstone, ...	
1853.						
Jan. 1st to Jan. 2nd,	4	1·93	0·48	297·89	Shale, ...	
„ 2nd „ „ 9th,	14	6·01	0·42	303·90	Sandstone, ...	
„ 9th „ Feb. 25th,	87	29·86	0·34	333·76	Shale, ...	
Feb. 25th „ Mar. 1st,	1	0·55	0·55	334·31	Coal,.....	Bored a "Core."
Mar. 1st „ „ 2nd,	1	0·46	0·46	334·77	Shale, ...	

Kreutsberg, near Forbach (Moselle.)

TABLE OF MONTHLY COST OF BORING.

Month.	Depth Bored.	Disbursements.			Division of Labour Expences.				Entire cost per Yard each Month (see below)	Entire cost per Yard for each 100 Yards.
		Total.	Plant.	Labour.	Borers	Smiths	Carpentrs.	Sundries.		
1852.	Yards.	£	£	£	£	£	£	£	Shillings.	Shillings
May	7·63	124·18	98·64	25·53	2·03	...	8·19	15·21	....	
June	8·99	193·77	134·03	59·74	47·85	3·38	3·18	5·31	25·99	25·99
July	71·75	114·38	47·40	66·98	51·31	4·14	0·28	11·25	28 77	2nd 100 Yards at per Yard. 43·50
August	35·77	109·02	50·56	58·46	49·02	3·88	2·12	3·44	43·39	
September .	5·22	55·98	....	55·98	45·77	3·94	0·11	6·16	232·54	
October....	6·69	61·36	12·52	48·84	31·74	2·30	5·54	9·25	161·25	3rd 100 Yard at per Yard. 59·15
November .	38·27	65·24	3·38	61·86	51·58	3·74	...	6·53	42·70	
December..	32·65	82·73	7·85	74·87	65·20	3·75	0·19	5·74	57·03	
	296·97	806·65	354·38	452·26	344·50	25·13	19·61	62·91	41·06	

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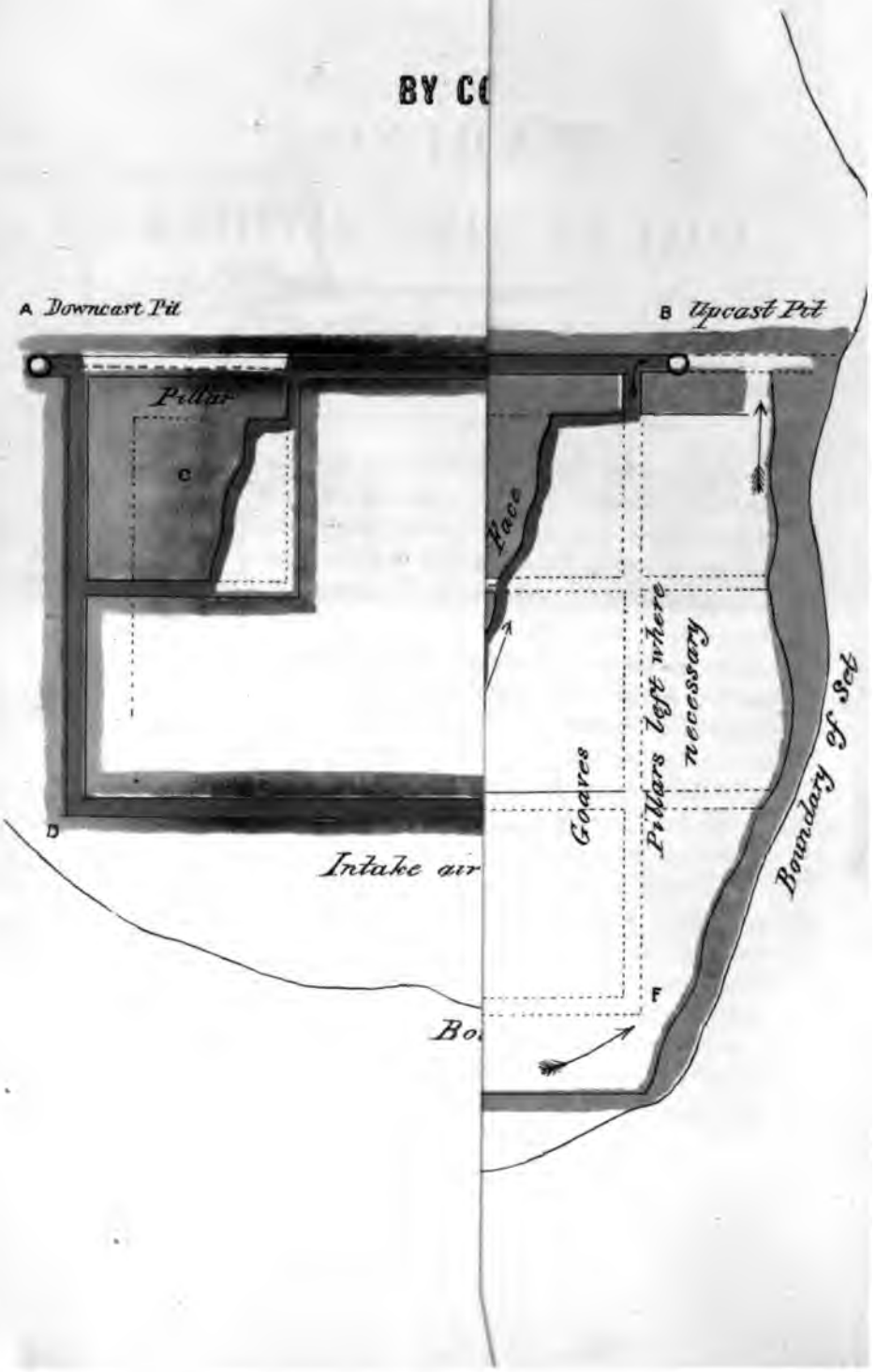

A Downcast Pit
B Upcast Pit
Pillar
C
Face
Pillars left where necessary
Goaves
Boundary of Set
D
Intake air
F
Bo

WARING'S
COAL CUTTING MACHINE.

By HERBERT MACKWORTH.

The primary cause of the accumulations of explosive gases in mines, and therefore of the serious accidents which ensue, is (in the great majority of instances), the compelling air to descend along airways in those parts of the mine in which fire damp may possibly exist. In mines where the upcast shaft is not to the rise of the workings, it may be requisite to allow the air to descend in order to enter the bottom of the shaft, using, however, in such a case, great precaution, and excluding all exposed flame from that portion of the mine. To make the ventilation, as it is called, "ascensional" in other parts of the mine, it is necessary to have a return aircourse to the rise of the workings. To facilitate the carrying out of this essential provision for the safety of every fire damp colliery, (but one too generally neglected), every encouragement should be given to more rapid and economical modes of driving airways.

The success which has accompanied the tendency of the present age to substitute machines for hand labour, holds out the prospect of success in applying machines to cutting a uniform substance like coal, and driving airways through it. This application would have an important bearing on the safety of mines on other grounds, in enabling mines to be more rapidly opened out, and the seam to be intersected, or the winning to be surrounded by airways so as to drain out the gas; in rendering more common the mode of driving first, out to the extremities, and then working back towards the shaft; or in uniting two collieries

with the view of improving the ventilation. Several machines have elsewhere been attempted without success, which may in some degree be attributed to their being too close an imitation of the Colliers pick.

Mr. Charles H. Waring, the Mining Engineer of the Neath Abbey Coal Company, has constructed several ingenious working models, and a machine, worked at present by two men. From its performance under these circumstances, it is very desirable that steam power should be applied to it. Annexed is a plan which Mr. Waring has submitted to me, showing the mode of opening out a colliery by the use of his machine, so that it may yield its full average of coals in the shortest time after the shafts are down, and so that the coals may be worked "in descending," which is necessarily the safest manner.

The Hand machine, of which two views are given, consists of two saws, which make the upper and lower parts of each cut respectively, and are advanced alternately, one before the other, by means of a screw After numerous trials, extending over a period of 5 or 6 years, of various kinds of circular and other cutters, the form of teeth exhibited is found to yield the best effect. The weight of the machine is 2 cwt. It is held firm by vertical screws, and occupies a space in the heading about six inches in width. It cuts, when worked by two men, a groove 4 feet long, ¾ of an inch wide, and 20 inches deep, at the rate of an inch deep per minute in an unfavourable seam of coal, which has a parting of 15 inches of shale and bad coal near the middle of the seam. The machine can be at once adjusted, so as to work vertically, diagonally, or horizontally, and take advantage of the slips and partings which intersect the face of the coal. Mr. Waring proposes to attach a small air cylinder to this machine, connected by pipes with an air forcer on the Water Pumping Engine. The air thus discharged near the roof of the heading, would be sufficient, in many instances, to dilute the gas given off without the necessity of driving, as is usual, a second parallel airway, connected with the first at intervals by thirlings. Under such circumstances an important saving might be obtained. Engine power is about to be applied to the machine for the purpose of driving a heading 1,800 yards in length, at the Bryndawe Colliery, near Neath, and, even should this prove to be as expensive as the ordinary system of driving airways, an important gain will, in my opinion, result in the time required for opening out a colliery.

The following is Mr. Waring's statement of the estimated effect and cost.

"To drive a heading, 6 feet wide in a 6 feet seam, 5 vertical cuts are

"made in the face 18 inches apart, and 1 horizontal cut at about midway "between floor and roof, each cut being 2 feet deep. According to the "power of the engine applied this cut may be deeper, and the speed of "advancing may be increased above $\frac{1}{16}$th of an inch per cut? At this "speed and at 64 strokes per minute the machine will cut 4 inches per "minute, or each cut in 6 minutes, which gives 36 minutes for the time "occupied in the 6 cuts. Whilst the machine is cutting, the men can be "at work at the side of it wedging down and filling. For moving the "machine, wedging down, and filling, allow 24 minutes. Then in one "hour, 2 feet will be cut, or 16 yards per 24 hours.

"A few horse power can frequently be spared from the pumping en-"gine, but say that a separate engine will be required:—

	£
"Then 10 horse high pressure engine, horizontal cylinder, boiler, forcers, &c., ...	300
Four inch pipes in pit, says 100 yards, ...	100
Fixing reservoir for air, &c., ...	100
	500"

"This engine compresses the air and forces it through the pipes, from "which it is taken to the air cylinder on the Coal Cutting Machine by a "flexible hose; fresh pipes being laid, as required, to bring the "main" "up to the face of the work."

"Interest and wear and tear on capital to bottom of pit, 10 per cent. per annum,=£50, or 3s. 4d. per day÷by 16 yards, ...	=3d. per yard forward.	
Pipes in heading, 3in. at 3s. 6d. per yard,....	=3s. 6d. „	„
Enginemen (the pumping enginemen may attend partly) to expenses	=10s. per day	
Machine men and fillers, 3 turns, 2 men in each, 6 men at 4s.	=24s. „	
Machine, ...	=10s. „	
	44s.÷by 16=2s. 9d. „	„
	6s. 6d. „	„

"But if the pipes, &c., are afterwards used for driving machines, and "cutting coal in the stalls and faces of work, the whole of this capital "should not be charged on one heading; and if used only for driving the "airways, and then removed, the above cost will be reduced by the value

"when removed. The value of the coal is not taken into consideration.

"The engine, or cylinder, will be proportioned to the hardness of the "coal, and the speed with which it may be cut. The quantity of air "delivered at the face of the heading may amount to 200 cubic feet per "minute, and where this is not sufficient, brattices or air trunks may be "used, as at present, to increase the circulation of air."

The cost of labour in some parts of England, as compared with the coal producing districts of the Continent, which are gradually coming into competition with our own; and the restriction of the production of coal which the scarcity of labour imposes, will, I confidently hope, direct the attention of the Members of the Institute to the merits of this Machine for Cutting Coal, which is the result of many and varied practical trials.

FIG. 1.

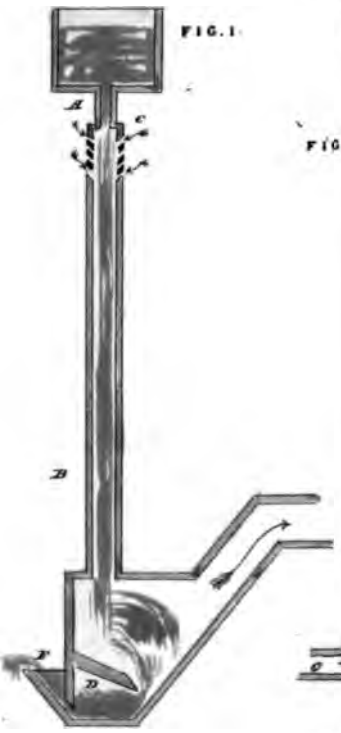


FIG. 2.

FIG. 4

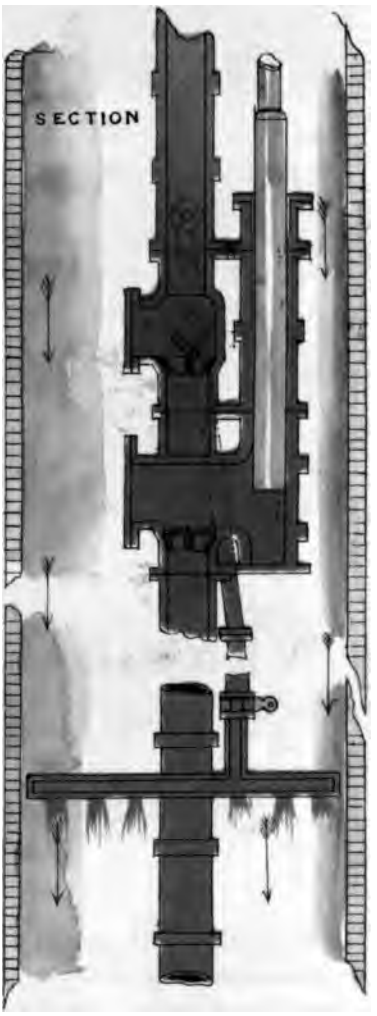
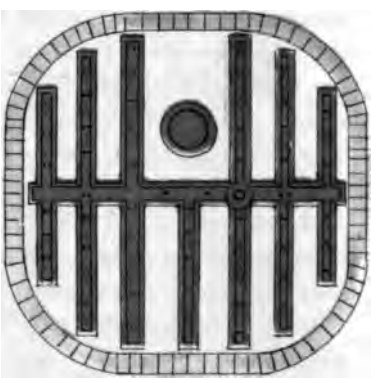


FIG. 5.

FIG. 6.

PLAN



SCALE 2 IN. = 1 FT.

Reid & c 117 Pilgrim St Newcastle

WATER

AS A

VENTILATING POWER.

By HERBERT MACKWORTH.

When the natural ventilation of some collieries becomes languid or an explosion has rendered the employment of a furnace dangerous, the most common resource is to turn water into the downcast shaft, for few pits are without an excess of pumping power. The fall of water being unequally distributed over the area of the shaft produces, to some extent, rotatory, or reverse currents in the shaft, and its ventilating effect seems mainly due to the cooling and consequent increase of weight of the downcast column of air.. The air again heated by the surfaces of the mine, the lights, the animal heat, and rarified by the exhalations and saturating vapour, ascends the upcast with a velocity proportionate to the square root of the difference in the weight of the total columns of air resting on the bottoms of the two shafts. Water, under these circumstances, must be classed with natural ventilation, as producing motion by temperature.

There is in this application a motive agency of a mechanical kind which is nearly altogether lost, and which, from its small first cost and easy

application, might be employed with advantage in sinking shafts, and ventilating small collieries, where the furnace or other motive power might be inconvenient. This application of water has been long known in some mining districts, and where a head of water can be obtained on a hill side, and there is a level or adit to conduct the water away after having performed its duty in falling from a sufficient height, it is probably the most economical ventilating power which can be employed. In North America the air brought down by natural waterfalls is collected in its compressed state by suitable vessels, and employed as a motive power for machinery. Similar in its effect is the air-trunk, used on the Continent for ventilation, which has been found to yield a useful effect, amounting to 15 per cent. of the motive power.

The Section is given at Figure 1. The cylinder, or supply pipe A, is made just large enough to take the required quantity of water. The lower cylinder, or trunk B, is made about three times the area of the upper. At C, are a number of sloping holes, through which the air is drawn, and the water by its fall and by breaking on the sloping block D, ejects the air by the air-trough E. The water overflows at the orifice F. In one instance the air is forced through a tube of 4 inches in diameter and 450 yards in length, after leaving the machine for the purpose of ventilating part of a mine. The height of the fall is 30 feet, and the compression of the air is measured by 33 inches of water. The water supply pipe has been made as much as 9 inches in diameter, with a discharge of water of 100 cubic feet per minute. It is thought by some that several air-trunks of 16 feet fall, each placed one below the other, produce more ventilation than a long one possessing their united fall.

In mines in Cornwall a somewhat similar contrivance exists for airing the ends of drifts or the rise of a winze. The winzes being 10 fathoms in depth, this is a common height for the fall, (A) Fig. 2 is the conduit trough, (B) are bars to break the stream and entangle the air, (C) is the outlet air-trough. The bottom of the trunk is usually fixed two or three inches below the surface of the water in the receiver, which gives an indication of the pressure exerted. Although the pressure of the air which can be obtained by the above arrangements is considerable, the contracted area of the pipes and the excessive proportion of the water used to the air which they impel, render them unsuitable to a considerable ventilation. There are several means of remedying this by employing the enormous pressure which the depth of an ordinary shaft can afford.

This mode has been employed, with success, in the drifts of the

Merthyr Tunnel, lately constructed. Two of the shafts were 1,270 yards apart, and it was found advisable to drive a single heading, 7 feet by 6 feet in size, to a length of 700 yards. The air was carried in by troughs, but delay being experienced from want of air and from powder-smoke hanging in the face after shots were fired, a waterblast was fitted into the horizontal air-trough, as represented in Fig. 3.

The shaft was 94 yards in depth. An iron pipe 1 inch in diameter being brought from a cistern at the top, down a trough, branched off at the bottom on each side, as shown in the sketch, and terminated in 2 roses or bellmouths. The escape of the water was regulated by cocks and 6 holes, each $\frac{1}{16}$ inch in diameter, were drilled into each rose. The top end of the pipe was turned horizontally, ending in a rose, pierced with still more minute holes to exclude dirt. The enormous pressure forced out the water like a blast of condensed steam. The current of air attained a velocity of about 1,200 lineal feet per minute, through a trough of 10 inches square, and nearly 800 yards long, clearing out the smoke from the working face, and returning by the heading to the shaft. The other branch pipe and jet performed a similar office for the tunnel, on the other side of the shaft. The discharge of water from each rose did not exceed a fraction of a cubic foot per minute, and it ran out to the open end of the tunnel.

The application of this method to sinking shafts needs no recommendation. The water can be readily intercepted before it reaches the bottom of the shaft. This application of water is capable of great extension. Pipes of 2 or 3 inches diameter can be connected with the pumps or with water confined by tubbing in the shaft, or be brought down from the surface, and the water can be discharged through a number of holes, sufficiently small to break it up into the finest spray, but with sufficient momentum to spread outwards and fill the area of a shaft. The arrangement of the jet holes in one or more roses can be accomodated to an area of any shape, the larger holes being placed near the circumference. An arrangement of this kind in connexion with the highest lift of pumps in a shaft is shown in the sketch. (Fig. 4.) Its cost would be about £10. It would be useful in collieries subject to fire-damp, to be set in motion on the occasion of any explosion or other emergency, when ventilation could be carried on entirely by the pumping engine. In two instances in which I have had this new motive power applied to the whole area of the shaft it has produced very remarkable results. Another method, of which imperfect modifications are not uncommon, combines the air-trunk with the

waterblast, as shown in the sketch. (Fig. 5.) The air enters the vertical air-trough by numerous holes in the upper part of its sides, and the effect of the accumulated velocity of the water is transmitted to the whole area of the shaft, by causing the stream, broken up by the intermixed air, to diverge outwards at the lower extremity. Forcing air being attended with a greater loss of power ordinarily than exhausting, these jets can sometimes be arranged for the latter object.

NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS.

GENERAL MEETING, HELD ON THURSDAY, MARCH 2, 1854, IN THE LECTURE ROOM OF THE LITERARY AND PHILOSOPHICAL SOCIETY, NEWCASTLE UPON TYNE,

WM. ANDERSON, ESQ., V.P., IN THE CHAIR.

The minutes of Council were read by the Secretary, Mr. Sinclair, and approved.

Mr. SANDERSON then called the attention of the meeting to a resolution passed at the last General Meeting, when he was not present; which resolution was recorded in the printed report of the proceedings as follows, "That this meeting is of opinion that the time has arrived when it is essentially necessary that a Mining School and College of Practical Science should be established in this district; that this Institute appears to be the most suitable body to take the initiative in such an object; and that the Council be requested to consider and report to the Institute the necessary preliminary steps to be taken towards the establishment of such an Institution." What he wished to remark here was this, that he did not think the words of the resolution were in strict accordance with truth; for, he held in his hand the report of an inaugural address on the establishment of a School of Medicine and Practical Science, in this town, in the preliminary proceedings of which the President of this Institute took a part, and he could not see how it was now desirable that this Institute should take the initiative in the establishment of such an institution. He did not see

any notice taken by the President in his remarks, on introducing the resolution referred to, to the meeting, of the existence already in this town of a College of Practical Science. There was, certainly, an allusion to the differences that unfortunately prevailed among the members of the Medical Profession; but, none to the existing College of Practical Science, and therefore he thought the language of the resolution, adopted at the last meeting, was not strictly correct. It was incorrect to say that this Institute should take the initiative, simply because such an institution was already established. He happened to be a member both of this institution and the other, which, he had trusted, would have had more co-operation from the Viewers than had been met with, especially, as Mr. Wood said, we could not undertake such an object successfully and satisfactorily without the co-operation of the Mining Engineers of the district. He quite agreed with Mr. Wood that a College of Practical Science, efficiently conducted and properly supported, would do honour to the district. Certainly, the one in existence had not made that progress in the department of Practical Science which, on its establishment, they were led to anticipate; but as far as the Medical School in connexion with it went, it was in active and successful operation. What he now proposed, was that the resolution passed at the last meeting should be reconsidered, and that some notice should be taken of the institution already in existence, and which was set a-going by the assistance of the President himself. It was desirable to avoid difficulties, if it were possible to do so, but he did not think the course which this Institute was now taking, was conducive to that end. If persisted in, it was probable they would not only have two Medical Schools in the town, but two Mining Schools. There was allusion made by the President to the University of Durham in his observations at the last meeting. Now, there were certain reasons existing why the two Medical Schools could not go in union together, and one of the principal of them was the connexion with the University of Durham. He thought, therefore, under all the circumstances, if anything could be devised to prevent discordance in this matter it would be very desirable.

Mr. Longridge said he thought it would be in the recollection of the members of the Institute, that a Committee was appointed to communicate with the College of Practical Science, the University of Durham, the Literary and Philosophical Society, and other scientific bodies in the Town, with the view, if possible, of securing their combined action. Attempts had been made to reconcile the differences between the medical schools, but had failed, and there did not appear any probability of such recon-

cilation being effected. He was sure every one there regretted, very much, the existence of these differences. If Mr. Sanderson was prepared, on behalf of the party he represented, to bring forward any proposition upon the subject, the Council of this Institute would, he had no doubt, be ready to give it their best consideration, but he thought that after the failure of the attempts which had already been made to reconcile the contending parties, Mr. Sanderson had no just ground for complaint against the Mining Institute.

Mr. SANDERSON said, what he complained of was that the resolution ignored an institution which was already in existence; whether it was going on as it ought to do or not was another matter, but its existence ought not to be ignored.

Mr. REID suggested the convenience of taking this discussion when the President was present.

Mr. DUNN considered the discussion premature. The Committee had not made their report, and until they did so the discussion ought to be deferred.

Mr. SANDERSON said, all he objected to was the wording of the resolution, which he thought not strictly correct.

The CHAIRMAN said he thought it would be better to defer any discussion on that point until the President was present.

Mr. SANDERSON concurred in that opinion, but as he was not present when the resolution was proposed, and this was the first meeting that had been held since, he had availed himself of the earliest opportunity of calling attention to the subject.

Mr. LONGRIDGE said, before the meeting proceeded with the reading of papers, there was one subject he wished to mention. They had gone on for a long time electing new members in a manner rather contrary to the rules, which provided that the members to be proposed should be nominated at one meeting and elected at the next.

The CHAIRMAN said that arrangement was only made until the Institute obtained premises of its own. The rule regarding the election of new members, provided that the names of members, proposed and seconded at any meeting, should be exhibited at the Rooms of the Institute till the next Monthly Meeting, when their election would take place. As the Institute had not yet obtained possession of their own rooms, the rule could not be acted upon, but it was understood that so soon as the Institute did obtain premises of their own, which was expected to be before the next meeting, the rule would be strictly enforced.

The SECRETARY said there were two papers by Mr. T. Y. Hall before the Institute, one being "On Safety Lamps, and Improvements in Colliery Workings;" the other on "Penetrating Dangerous Gases." The first of these papers had been read, and stood over for discussion; it had not been discussed at the last meeting in consequence of the absence of Mr. Hall.

Mr. M. DUNN, referring to an observation he had made at a former Meeting, and the conclusion then come to, said he thought it was hardly competent in the Society to pronounce an opinion in favour of any particular Lamp; it was better to allow the inventive genius of the country to take its course, and the various practical parties concerned in Mining, would, from their own knowledge and experience, select the Lamp that was best and safest under the particular circumstances of each case.

Mr. LONGRIDGE said that he perfectly agreed with the opinion expressed by Mr. Robt. Stephenson, at a former meeting of this Institute, that it would be very undesirable to commit the Society to any formal expression of opinion on the subjects brought under discussion.

The SECRETARY observed that the papers had been read, and any gentleman was at liberty to express an opinion upon the subject in the course of the discussion, but such opinion would only be taken as that of the individual making it.

Mr. DUNN said he thought it desirable that Mr. Hall should state the advantages his Lamp possessed, if any, over other Lamps in existence. Would Mr. Hall state in what way his Lamp was superior to those of Clanny, Davy, Glover, Stephenson, and others?

Mr. HALL said, he thought it best to place the Lamp before them, and allow them to judge for themselves. His great object had been to produce a Lamp that would combine all the advantages required both for light and safety. It was put together in a workmanlike manner, and he would leave them to judge whether it was better than others or not. Mr. Mackworth had read a paper at the last meeting of the Institute, in which he described a Lamp which he recommended in preference to what he calls "the more perfect Lamps of Glover or Hall." Why give preference to a Lamp that was less perfect, over others that were more perfect, Glover's was a Glass Lamp. Here was his Gauze Lamp, one which produced more light, and combined great safety, which was not cobbled up and put together in a rough way, but was completed in a workmanlike manner. He had been engaged upon the subject six months before Mr. Mackworth had first brought his Lamp forward, and he found that he could not cobble up a Lamp to make

a perfect one; the consequence was he was obliged to set to work with a workman who never had anything to do with a Lamp before, and who, the principle being new, had nothing to take his attention from going on with the work, and he considered they would find he had made a very good job of it.

Mr. LONGRIDGE said that, as he observed in the Lamp brought forward by Mr. Hall, silvered wire gauze was adopted, he wished to know if in Mr. Hall's opinion there was any difference in the quantity of light transmitted through silver and iron gauze.

Mr. HALL said, from his own experiments he could not discover any difference in the light; the light let out depended upon the number of holes in the wire; the smaller the wire the great number of meshes there were in a square inch; he found that he got more light from gauze with 1,296 holes, than with 784, that he got more still with 2,500, which was the Lamp produced, and he even had Lamps made which went up to 6,400, and even from that to 10,000. The fine gauzes he found to be sufficiently strong for the purpose of safety.

Mr. LONGRIDGE,—But you did not think there was any difference arising from the colour of the wire, as far as that goes?

Mr. HALL,—I did not think so; I tried it with a photometer, and I prefer the colour of Platina to that of either silver or iron; the Platina colour is produced on the iron by annealing the wire without air in a hot casing.

Mr. DUNN,—What size of gauze does Mr. Hall recommend?

Mr. HALL,—I have tried about double the number of holes in the Davy with good effect. I have got a good light with 1,296 holes in the gauze.

Mr. BARKAS said he thought it necessary they should know something of the metal the gauze was made of; for Mr. Wood had stated that copper gauze was dangerous to make use of in a heated atmosphere. It was desirable to know which was the best for that purpose.

Mr. REID said, in the experiments that were made by Mr. Wood, it was found that copper wire gauze passed the flame more readily than iron wire gauze.

Mr. HALL said he was present at the experiments, and believed the Lamp made use of in these experiments referred to was a surveying Lamp made with brass wire. He preferred iron or platina wire, but copper wire was better than brass.

Mr. DUNN,—According to Sir Humphrey Davy's opinion, iron wire was best.

Mr. HALL,—But in the way my Lamp is constructed the gauze has

no connexion with the flame, being protected from it by a cylinder, of glass,

Mr. Boyd,—But the glass may break.

Mr. Hall,—Even in that case my Lamp would still be a safe Lamp.

The Secretary said he thought Mr. Hall had somewhat misunderstood Mr. Mackworth's observations with reference to the preference to be given to the Lamp he described over other "more perfect" ones. Mr. Mackworth was favourable to the principle of Mr. Hall's Lamp, but preferred a simpler and less expensive mode of construction.

Mr. Hall said he had not read the remarks in that way; but he thought there were other remarks in the same paper that ought not to pass without observation. Mr. Mackworth had made some remarks upon the ventilation of Foreign Mines on the Fan blast system, which, he said, were superior in that respect to English Mines, in which he, of course, included all the mines of this district, making, in his evidence before the Committee of the House of Commons, in respect to the latter, four or five exceptions, which he now extends to fifty. Exceptions were were made in favour of Hetton, Tyne Main, and Killingworth, which were ventilated on the furnace principle; and, he supposed also Seaton Delaval was alluded to, as they now got there more than 70,000 cubic feet of air per minute, from the operation of the Steam Jet. Now, he considered that in all the collieries in this district were doubly better ventilated than those in Foreign Parts, leaving the great mass of the collieries to which Mr. Mackworth had referred, in his own district, which he had had the power over two or three years to improve. Even his one or two model collieries were not equal to the worst of those of Northumberland and Durham. This was a matter for the Viewers rather than him to take up, because it was a slur upon their character to which they ought not to submit. If in Mr. Mackworth's district, where he speaks of wanting to have good locked Lamps the practice of the men has been to use false keys so long and to such an extent as to wear large holes in the brass, the pitmen of Northumberland and Durham ought not to be included. A Government Inspector seeing that practice prevail, and having power to prevent it, ought to have put a stop to it long ago. If such practices prevailed in Mr. Mackworth's district that was no reason why he should cast a stigma upon the Viewers of this district, and the miners generally in Northumberland and Durham, where, for the last twenty years, at least, such a practice had not prevailed.

Mr. Dunn said Mr. Mackworth had, no doubt, founded his opinion

upon the statements on ventilation made to him by official, and scientific men.

Mr. HALL,—Are you of the same opinion?

Mr. DUNN,—Certainly not; but the statement was given in evidence before a Committee of the House of Commons as the result of official inquiry.

Mr. HALL,—Did it include the mines of Northumberland and Durham?

Mr. DUNN thought it did; and it seemed to be Mr. Mackworth's opinion from the investigation he had made.

Mr. HALL put it to Mr. Dunn whether the worst of our Colleries were not better ventilated than those in Belgium and on the Continent.

Mr. DUNN admitted they were, but said he spoke merely as an amateur, whereas Mr. Mackworth spoke officially, after having. examined everything.

The CHAIRMAN,—Had not Mr. Mackworth some of his colleagues with him?

Mr. DUNN said Mr. ..... was with him.

The CHAIRMAN,—And Mr. Dickinson?

Mr. DUNN said he did not think Mr. Dickenson was with him.

The CHAIRMAN said he thought they could not look over the statement made by Mr. Mackworth without noticing it in some way or other. Having done so, they might now proceed with the other business to come before the meeting. Mr. Hall had also a paper upon Improvements in Colliery Workings; had any gentleman any observations to make on that subject?

No remarks were offered.

The SECRETARY then read a paper by Mr. Mackworth, on Coal Cutting by a Machine, of which a model and drawing were exhibited.

The SECRETARY, after reading the paper, said he believed Mr. Peice had also taken out a patent for a Coal Cutting Machine, which would probably come before them at another meeting, so that it was evident the subject was attracting attention.

Mr. HALL said he was very certain his friend, Mr. Peice, would give an honest opinion upon that or any other subject he might speak upon.

Mr. BARKUS observed that nothing was said about sharpening the teeth in Mr. Waring's machine.

(A MEMBER,—There would be no difficulty in grinding them if necessary.

The CHAIRMAN said the next subject to come before the meeting was a paper by Mr. Mackworth, on "Water as a Ventilating Power."

Mr. T. Y. HALL asked if the mode described by Mr. Mackworth was an original invention.

The SECRETARY said Mr. Mackworth described what he had seen upon the Continent. and the Water Power was used for ventilating in America.

The paper having been read, the discussion of it was deferred until the next meeting.

Mr. HALL said he had not found any better mode of ventilation in America than that adopted in this neighbourhood, and he found if we resorted to water-power, we had not the mountainous streams to work with, which were sometimes found in America.

Mr. T. Y. HALL then brought the subject of a paper which he had laid before the Council, on Penetrating Dangerous Gases, and enquired why that paper had not been brought before the meeting. After some discussion as to the propriety of deferring it, the paper was read.

Mr. T. Y. HALL in reply to an inquiry from the Chairman, said he should have a lengthy document on the Coal Trade and the probable duration of our coal fields, of which he had given notice to the Chairman, in readiness to be brought forward at the next meeting.

A new anemometer, the invention of Mr. Dickenson, the Government Inspector of Mines for the Lancashire district, was exhibited by Mr. Reid, and elicited the approval and admiration of several of the members.

It was of a very simple construction, consisting of a Fan of Talc, suspended and properly balanced so as to reduce the friction to a minimum. A quadrantal arc graduated on one side shewed the number of feet of air passing in each superficial foot of area per minute, the instrument being placed at right angles to the current of air, and properly adjusted by means of a small plummet attached, and protected by glass, the whole arrangement being so contrived as to fold up like a book and go into a moderate sized waistcoat pocket.

Mr. REID observed that Mr. Dickenson had sent him the instrument for exhibition at the February meeting, but, only receiving it upon entering the Room, he was unable to speak to its merits. After a month's trial, however, he had much pleasure in speaking approvingly of its merits. It had been carefully compared with other anemometers during that period, and he could testify to its being an instrument of very simple

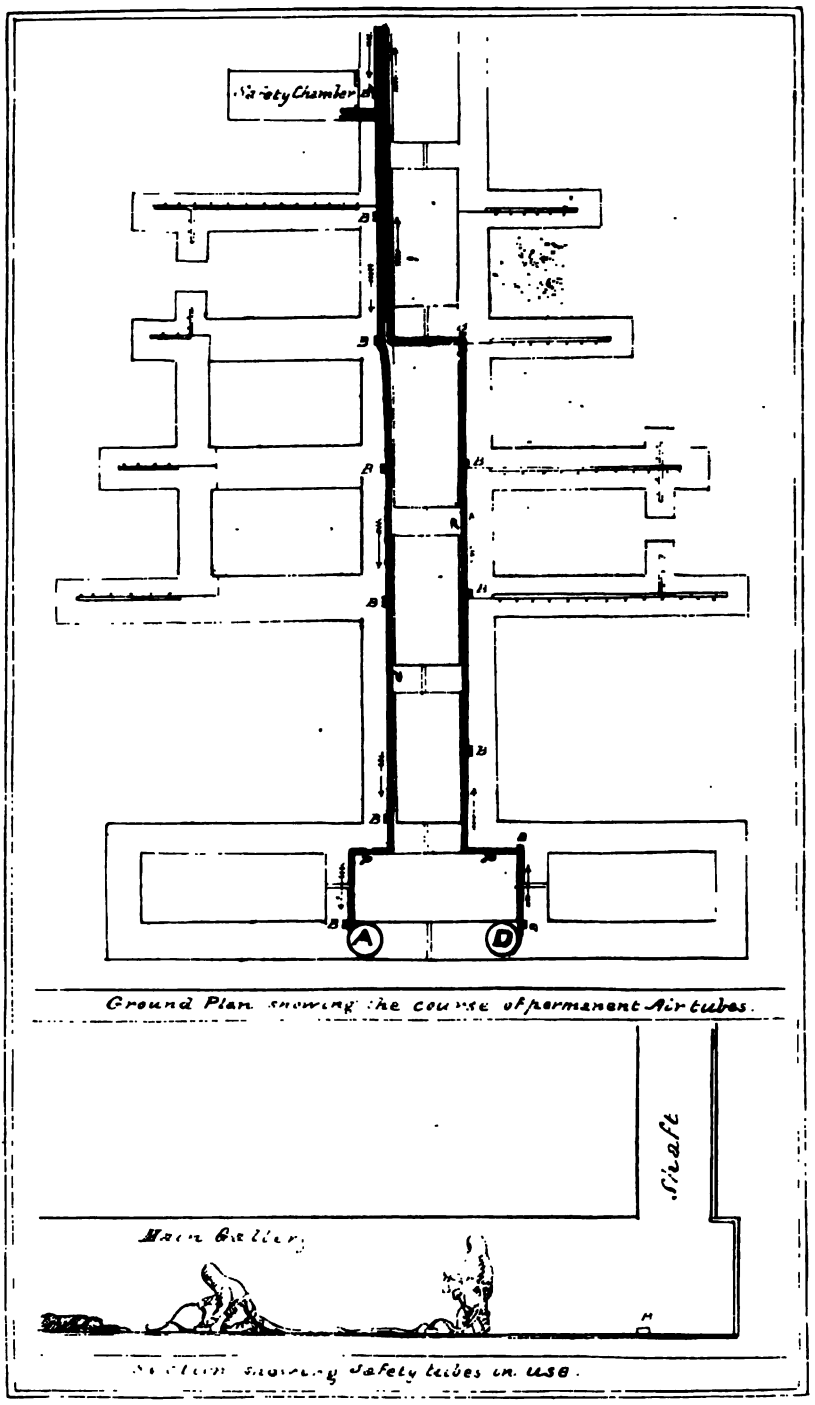
construction, and of a most easy and convenient application, well adapted to the requirements of underground Inspectors, Wastemen, &c., &c., especially in narrow air-courses, and whose time would not admit of the lengthened observations necessary in using other anemometers, which generally occupied minutes to ascertain properly the velocity, whereas the object was attainable in a few seconds with Mr. Dickenson's.

The CHAIRMAN highly approved of the little instrument exhibited, and observed that everything, of course, depended upon the adjustment and graduation of the index.

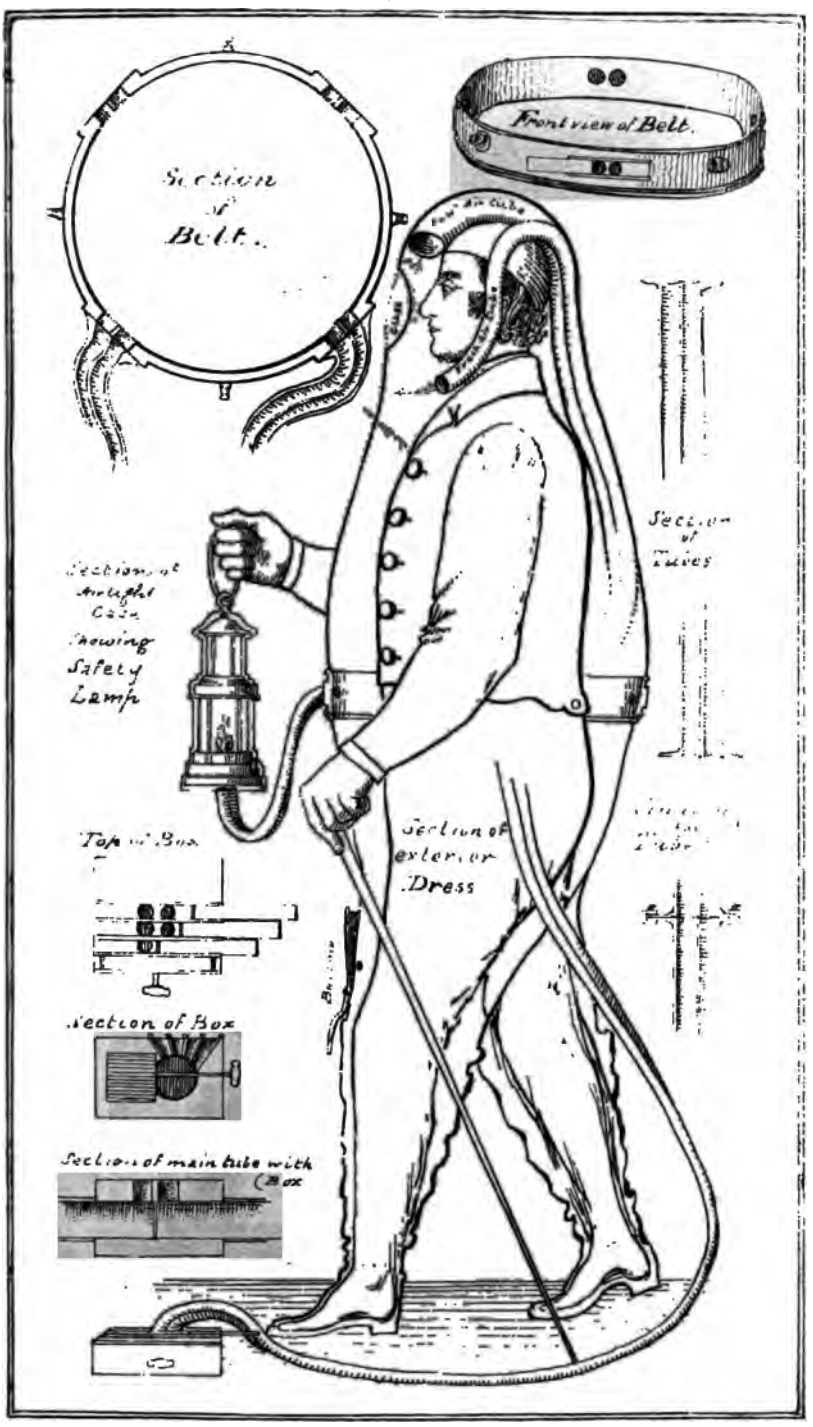
Mr. REID observed that the original graduation was carefully compared with the best instruments of the kind made in Paris; and that he understood from Mr. Dickenson that great pains were taken to ensure correctness. So far as it had been tried during the past month it agreed to a nicety, after due allowances made with the other anemometers for friction, on each trial, and he had no hesitation in recommending it for its convenience and ready application alone.

Adjourned.

PLATE I.



Mr. T. Y. HALL'S Plan for penetrating dangerous Gases.



Mr. T. Y. HALL'S Plan for penetrating dangerous Gases

PLATE III.

Mr. T.Y. HALL'S Plan for penetrating dangerous Gases.

PENETRATING
DANGEROUS GASES.

By T. Y. HALL,

ELDON SQUARE, NEWCASTLE-ON-TYNE, 1853.

ILLUSTRATED WITH DIAGRAMS.

The annexed diagrams represent and illustrate a simple, practical, and commodious plan for enabling a man to penetrate, without delay, to great distances, to abide there some time, to obtain a knowledge of the circumstances, and act freely in Under-ground excavations filled with dangerous gases, and was submitted in competition for the prize of 2,000 Francs offered by the Belgian Government, and the Gold Medal of the Royal Academy of Belgium, for a good, simple, and safe mode of effecting these objects.

The plan so described consists of safety pipes of metal, glass, earthenware, gutta percha, or any solid material laid down permanently in the thill of the main galleries of the mine, in the direction taken by the air, from the top of the down-cast shaft into the workings, and back through the "return," to the "upcast." There may either be two pipes laid parallel to each other throughout the whole course, with a junction at a certain point, or a single continuous pipe, may be used both for the fresh air and the return.

These are represented in Plate 1., where D is the downcast, A the

upcast, P the permanent pipes, the course of the air in which is indicated by arrows; B the boxes, at which the air is stopped or trapped. The shaded surfaces represent solid coal, and the white spaces, boards, or openings.

The circulation of air through these permanent pipes is constantly maintained by means of a steam jet, air pump, furnace, or other means for accomplishing ventilation of the mine for working purposes.

These permanent safety pipes are provided with boxes, or joints, at intervals of between forty and fifty yards, for the purpose of stopping or trapping the air; so as to guide it through portable tubes into an air-tight dress, or into safety chambers, where the workmen may take refuge, or into other safety pipes traversing the boards or galleries.

These boxes or traps are of a cubical form, and have slides and apertures on the top inserted into grooves, so as to admit of their being withdrawn for the purpose of introducing into the same grooves the end of a double portable tube made of Gutta Percha, India Rubber, or any other flexible material, such end being adapted to slide into these grooves in such manner that the apertures of the flexible tubes shall exactly correspond with the apertures in the permanent pipes.

Between these apertures in the boxes or traps of the permanent pipes, a stopper is or may be inserted, so as either partially or altogether to interrupt the course of the air, and direct it into one of the apertures, (A) or of the flexible tubes, whence it will be carried forward into an air-tight chamber, dress, or casing, in which the person penetrating the mine is to be enveloped, returning thence by the other portion of the tube and through the other aperture (A) into the permanent pipe.

The portable tubes are used for the purpose of penetrating the mine by first fixing one end to a trap or stopper, and the other to an air-tight dress, or casing, in which the party penetrating the vitiated air is enveloped.

This party proceeds forward to the next trap or stopper, where he is furnished with the means of detaching the end of the tube from the first stopper, and affixing it to the one at which he has arrived. The contrivance for effecting this is very simple, and may be easily applied; but if two individuals go in at the same time, which is recommended, they can do so by means of the same tube, and thus they will inspire mutual confidence, while they render mutual assistance, and are enabled to penetrate the galleries more quickly than could otherwise be done.

In case any of the boxes or traps should get out of working order, which

would be very improbable, and it should become necessary to extend the portable tubes, that may be easily done by placing their flat or slide ends together, and fastening them by means of nut and screws.

The air-tight dress, or casing, may cover the whole body, or only a portion of it, as may be thought proper. In either case there would be a belt of brass, or other metal, to go round the waist, having an overlap for the purpose of uniting the upper and lower portions of the dress: such belt being constructed with apertures and slides, similar to those in the permanent pipes, for the purpose of attaching one extremity of the flexible tube thereto when necessary, and carrying the air into the body and head dress, in order to supply a sufficiency of pure air to, and remove deteriorated air from the individual penetrating the mine.

The feet will have an additional protection of sole leather, or gutta percha, to prevent the dress being cut in that part while passing through the galleries of the mine. A pipe, having a self-acting valve within it, might be placed in communication with the brass belt, so as to admit of air being forced through it by means of a pair of bellows from the inside of the dress when necessary, to supply pure air and other restoratives to any of the persons who had been injured by the explosion, and who were still in the mine, but unable to move without assistance.

The upper part of the air-tight dress may be made sufficiently wide to admit of the arms being withdrawn from the sleeves, and the hands applied to any useful purpose inside the dress.

The metal belt will be kept in its proper place by means of leather straps attached to the body, and will be provided with suitable crooks on which to suspend, when necessary, one or more reserve coils of flexible tubes, a capacious pouch, and a Safety Lamp. There will also be pockets inside the dress, for putting anything into that might be desirable to take into the mine.

In every case of an explosion, it would be advisable to put on the air-tight dress at the top or bottom of the shaft, although the shaft and even the main galleries may be penetrated for a considerable distance, without danger, in consequence of the air in those parts not being contaminated. Generally, however, the deteriorated or foul air is met with before reaching the district where the explosion took place.

On arriving at such places, it will be necessary to apply the flexible tubes.

In order to test the quality of the air in the mine after an explosion, and its capability of sustaining life, it would be advisable for the parties

as they advanced along the galleries of the mine, to observe the effect of the air outside the dress, on some living animal, such as a dog, cat, or other animal of less value. By making such observations, a pretty correct judgement might be formed as to the probability of any of the miners surviving amongst the contaminated air or gases.

The Safety Lamp will be enclosed in a proper covering of metal, or glass, or partially of both, the air being supplied to it by means of a tube attached to the metal belt. The heated air may be made to escape at the top, through a small portion of double wire-gauze, with 10,000 holes per square inch, protected by self-acting valve over it; or the heated air may be carried off by means of a return tube connected with the return tube inside of the dress, and thus assisting ventilation without danger or inconvenience. In either case, the Safety Lamp, invented by Mr. T. Y. Hall, of Newcastle, is recommended, as it is constructed upon a principal to burn without smoke, and combine great luminosity with perfect safety from explosion.

At each junction of the main pipes, where provision is made for the purpose of attaching branch pipes thereto, so as to form a communication for admitting the air into a glass case, to be placed against the wall in the gallery for the purpose of containing a Safety Lamp, to remain stationary, and be kept constantly lighted, if necessary. This would assist ventilation in the main tubes, and so illuminate the galleries as to admit of their being traversed at all times without carrying a lamp. Where air pipes are laid in the mine for working machines, for the cutting of coal, &c., the same pipes might answer this purpose also.

It is proposed that a sufficient number of air-tight dresses, or casings, be kept constantly in readiness at top or bottom of the shaft, together with a sufficient number of flexible tubes, so as to be available at all times. Tubes and dresses may also be kept at the principal flats or stations in boxes provided for the purpose.

As an additional means of safety for workmen in fiery mines, it is proposed to form Safety Chambers, or what may be termed Refuge Stalls, in such of the boards or openings in the galleries as may be thought advisable and convenient (See Fig. 1.) Such safety chambers should be air-tight, or nearly so, and ventilated by means of fixed tubes in connection with the permanent pipes, the entrance to be by two trap-doors, which can be opened only from the outside. A means of communication between the parties in these chambers, and those at the top or bottom of the shaft might easily be established.

It is respectfully submitted that the method above described is not only practicable, but commodious and safe, for enabling a person to penetrate, without delay, to great distances, to abide there some time, to obtain a knowledge of the circumstances, and act freely in underground excavations filled with dangerous gases. The plan has been described as applicable to Coal Mines; but it equally is so to all places where noxious gases or impure air exists. It is simple in principle, and infallible in its operation, at least so far as infallibility can be predicated of human means.

It is recommended that the workmen be frequently practised in the use of this apparatus so as to become competent to apply it when necessary, with as little delay as possible, as such can be practised at no cost.

The advantages to be derived from the introduction of the apparatus and system, herein described, into mines, would be very considerable, while the expense of doing so would be exceedingly small, particularly when done as the workings of the mine are in progress.

A pit that may have a capital of £50,000 employed in conducting it ought to pay for interest and redemption at least 8 per cent., or £4,000 per Annum. The extra sum required in order to have the apparatus and its appendages always in readiness, would form a very small addition to such capital, and would not be a sacrifice of interest to more than £20 a-year; whereas, when an accident did occur, by enabling the works to be resumed at a much shorter period than could otherwise be done, the saving of interest thereby upon the large capital embarked in the undertaking, would far more than counterbalance the small cost of the apparatus.

In short, so obvious are the advantages to be derived from the use of such apparatus in cases of accident, by enabling the lives of the men to be saved, and the works to be speedily resumed, that the Government ought to make it imperative upon all Colliery Owners to construct such apparatus on the opening out of every mine.

NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS.

GENERAL MEETING OF THE INSTITUTE, HELD IN THE LECTURE ROOM OF THE LITERARY AND PHILOSOPHICAL SOCIETY, NEWCASTLE UPON TYNE, APRIL 6, 1854.

NICHS. WOOD, ESQ., PRESIDENT OF THE INSTITUTE, IN THE CHAIR.

The Minutes of the Council Meetings having been read, the meeting proceeded to the election of members.

The PRESIDENT then stated that the subjects for discussion were Mr. Longridge's paper on Choke Damp, Mr. Mackworth's two papers, one on Boring according to the plan of Mr. Kind, and the other on Water as a Ventilating Power. He was happy to see a gentleman present who would probably offer some remarks in explanation of the system of Boring described in Mr. Mackworth's paper. They had also a Coal Cutting Machine before them, by Mr. Waring, of Neath, whom he was also glad to see present, and who would favour them with any explanatory observations respecting it, which might be thought necessary. There was, likewise, a paper by Mr. T. Y. Hall, On Penetrating Dangerous Gases, which had not been discussed. The regular course was to take the discussions first, and the reading of papers afterwards. The only paper to be read was one by Mr. Hall on the Extent and Probable Duration of the Northern Coal Field.

Before, however, (said the President,) we go on with the discussion, I think it necessary for me to notice some remarks made at the last meeting by Mr. Sanderson, whom I am very happy to see present to-day. I

regret that in consequence of an accident I was prevented from being present at the last meeting. The subject Mr. Sanderson brought forward was that of a Mining School and College of Practical Science, which it was proposed should be established in this district; and, in noticing which, I must first of all beg Mr. Sanderson clearly to understand, that it is not the wish of this Institute, myself, or any of the members thereof, to interfere in any way whatever with the College of Practical Science, which Mr. Sanderson states is in existence, and with which he is connected. I did deliver, as he stated, an address to that Institution with reference to the establishment of a College of Practical Science in this town. It is well known to most of the members present that a meeting was got up for the purpose in this building; I attended that meeting; and having always been very desirous, and feeling the necessity for such an institution, I gladly availed myself of that opportunity of, as far as I could, promoting such an object. The consequence was that I was asked to deliver a lecture in what was then called, and was intended to be, a College of Practical Science, in connection with the Medical College, which Mr. Sanderson promotes, viz., the College of Medicine on Rye Hill. In doing so, I was not aware, at that time, that there was any difference of opinion in the town upon the subject. I considered in doing so I was promoting the general interest of the district. No division of opinion, that I was then aware of, existed upon the subject, or that there were two institutions, of which I have since heard more of than I then knew. I have since found, and I regret very much, that there are two parties connected with the medical establishments, and that there are two separate medical institutions in the town. I have endeavoured in the promotion of the object I had then in view, which was the establishment of a Mining School and College of Practical Science, to promote a union between these two parties. Probably, like every other person who interferes in such a case, I have been blamed by both. Whether that is the case or not, however, my object was a straightforward one, which was the establishment of a College of Practical Science and Mining School. Those were the reasons which then induced me to deliver a lecture on the subject; and, since then, I have done everything which would in my opinion promote such object. I must, however, before proceeding further, notice one remark which Mr. Sanderson makes, wherein he alludes to the University of Durham. I am quite sure Mr. Sanderson will recollect that in the Lecture which I delivered, I made the same allusion to the Durham University as I did in the meeting here—that it would be a benefit to any institution of this kind to be associated with and assisted by the

University of Durham. I have stated that more than once, and, therefore, I think I may be excused for saying that I have ever been consistent on that point, being actuated solely with the view of having the institution established. Now, the reason why this Institute has taken up the subject so very strongly at this time, is that it is deeply impressed with the necessity of such an institution for the benefit of the mining population of this district. The Institute considers it of vital importance that something of the kind should be established. They have anxiously watched its progress week after week and month after month. It was brought, first of all, before the Institution of which Mr. Sanderson is a member. Afterwards a meeting was held in the town, at which Dr. Playfair was present, when a committee was organized for the purpose of carrying the object into effect. That Committee was constituted of both parties, of gentlemen belonging to both institutions, as well as other persons; and it was only when this Institute found that the matter was in a state of rest—that no progress was making whatever in it— that they took the subject up, with the view of carrying the object out, if it could possibly be accomplished. I am happy to say that since this Institute has taken this step, I have received assurances of support from gentlemen who are quite capable of carrying it to a successful issue—*(hear and applause)*—independent of support from other quarters. *(Applause.)* So deeply are they impressed with the necessity of such an institution, solely in a mining point of view, that they are prepared to support it to the extent I have stated, were it confined to that limit alone, yet they think it would be extremely desirable if such an institution could be associated with other Literary, Scientific, and Medical Institutions of the town. While, therefore, we consider it our imperative duty to look to the establishment of a Mining School in the first place—and while, I think, we shall be enabled to carry out such an establishment independently of any other branch of science—we are, at the same time, most anxious that all existing differences between the other Institutions should cease, and that such a united School and College might be formed as would do credit to the district, and accomplish all the objects in view. *(Hear).* I do hope, therefore, notwithstanding the differences existing between two very powerful bodies, of great influence in the town, that this very desirable object will yet be accomplished. We have, however, one course only to pursue, which is to go straightforward and with energy to work and endeavour to establish a Mining School, as to the necessity for which we are all agreed, and in which, I have no doubt, we shall succeed, and the probability is that we shall also be able to unite with it a College of Practical and General Science.

I do hope, therefore, without seeking to interfere with existing institutions, or with their differences, that both parties will rally round us, and that we may become a nucleus on which to engraft something generally applicable to practical science in this town. I do not know that I can say anything more on the subject at present. I think from Mr. Sanderson's own statement, that the Institution with which he is connected has not made that progress in the department of Practical Science, which on its establishment he was led to anticipate. I am very happy to find that the Medical School in connexion with that College has been successful. I am happy indeed to find from their reports, that both Medical Schools have been successful. If the gentlemen connected with them think two Medical Schools are better than one, we have no right to interfere; but such I believe is not the feeling generally. In conclusion, feeling the deep importance, in a Mining point of view, of such an institution as I have stated, and deeming it desirable that some effort should now be made to carry that object out, it was with that view that this Institute took the matter up at the time alluded to. I repeat again, in conclusion, that we do not wish to interfere in any way whatever with the interests of any other institution; but rather than that nothing should be done, this Institution must, from necessity, confine themselves entirely to the establishment of a Mining School, and so endeavour to promote the interests of their own profession, leaving it to time to accomplish a further extension.

Mr Sanderson explained the reason, and apologised for having called attention to this subject when the President was not present, as his observations were chiefly founded upon what the President had stated. He then proceeded—I am glad to learn from what you stated this morning that there is no intention on the part of this institute to interfere with institutions already in existence. In that case I do not think it can consistently assume the title of a College of Practical Science, which would give rise to two institutions having the same name. We have already two Medical Schools, and I think it very desirable that we should avoid, if possible, creating two separate Colleges of Science, which would only give rise to a good deal of ill-feeling that would be much better avoided. If, in any way, we could come to an understanding with the different institutions in the town, so as to secure their joint co-operation, it would be exceedingly desirable. It would be exceedingly desirable that we should go on in peace and concord one with another; but, as I said before, I am afraid if this institution take the name which has been already adopted by another institution you will in effect set up a rival institution

of your own; and I am sure if that were done it would produce a great deal of ill-feeling, that would be injurious to both sides. No doubt each would get friends. There would be a party on both sides, and such a state of things would be very unseemly. With regard to the University of Durham, the reason why I mentioned it was, that we felt and expected when we opened our Medical School that we should be put, with respect to the University of Durham, upon the same footing as the other Medical School in the town. We found the University quite indisposed to do so, they having taken a part with the other School, which, in fact, forms a part of their organization. One Hall, Neville Hall, in this town, was as much a hall as any in existence at Durham. Of course, when we saw that you were favourable to joining the Mining School and College of Practical Science with the University of Durham, much in the same way in which the Medical School is already joined, we felt quite sure if that were done it would be a great pity and cause a great deal of division in the town. To originate a College very much like that which is already in existence in the town would, besides, only be unsatisfactory to both parties. There is another circumstance which has excited a little degree of suspicion. The property which has been rented for the accommodation of this Institute belongs to the same proprietors as that occupied by the other Medical School. You have certainly a right to take the property of A., B., C., or any other party you find most convenient; but we felt a degree of alarm at this, and thought the matter looked a little suspicious, though in reality there might be no substantial ground for entertaining such a feeling. When it came out afterwards that you were about to establish another College of Practical Science in the town, we really felt afraid there was to be an attempt made to accomplish that in one way which had not been done in another. When I saw this, I felt it my duty to notice it, and to warn you against doing anything that might excite a bad feeling in the town. In practical science and in mining you must be more influential and more powerful than we are; you may succeed; but it will cause an unpleasant feeling and widen the dispute which already exists, and which it seems very desirable should be put an end to. I sincerely hope that will be so, though I do not see any prospect of it at present. I am glad to state, with respect to one of the Medical Schools of which I am treasurer, and therefore have good opportunity of knowing the facts, that it is doing well. It is not necessary for me to say more; but I would suggest that one or two of the committee of this Institute should communicate with one or two gentlemen connected with the Medical Schools, so as to consider if some plan might not be arranged to prevent any clashing of interests in this matter.

The PRESIDENT said—It is not desirable to prolong this discussion. I am very glad to hear the explanation of Mr Sanderson, and his expression of a wish that the two institutions should not clash together. I am sure it is not the wish of this Institute, or any one connected with it, that we should clash together. On the contrary, we wish to be united, and with that view we have endeavoured to promote a union between the two Medical Schools. I am very glad that Mr Sanderson seems to be of the same opinion as myself that it would be desirable there should be only one School instead of two. With respect to the name, "College of Practical Science," probably, by adopting it, we may have entrenched a little upon the title of another institution. It was with the expectation that their College of Practical Science should be incorporated with that of our Institution in some way or other, so that there should be only one College of that description in the district, that we adopted that title. Of course, if that object is impracticable, and we are compelled to establish a Mining School alone, unconnected with other branches of science, we cannot adopt the name which already belongs to another institution. We must confine ourselves to a Mining School, and, of course, adopt some other name. With respect to the University of Durham, I do not know at present what amount of assistance it will give us, except from what was stated before by the Warden, who said—"Tell us how to benefit you and we will do it. We will do anything to promote the advancement and interests of the mining population of these counties. Only tell us what we can do in that respect and we will do it." Mr. Sanderson is under a mistake with respect to the renting of rooms for the accommodation of this Institute. This Institute does not rent any rooms; the rooms being rented by the Coal Trade. And feeling the propriety of keeping a close connection with the Coal Trade, and the committee having allowed us to occupy a portion of the rooms in that building, we thankfully accepted their offer. Therefore, we are not tenants of the building, although we will occupy apartments in it. But, I still hope, notwithstanding all that has occurred, that some arrangement will be come to whereby a union may be established among the different institutes of the district, and I think the course this Institute is now taking is calculated to effect that object.

Mr. T. Y. HALL said, as Mr Sanderson had heard from the President that he was in expectation of great assistance in support of a Mining School, it behoved the other party and the two Medical Schools to try to come together in a friendly manner, to do away with all past differences, and join hand in hand. He believed, from what he had heard, and he

had opportunities of meeting with both parties, Dr. Charlton and Dr. Dawson, who were his neighbours, that both were very desirable of putting an end, if possible, to the unpleasant feeling that existed, so that they might go on harmoniously together, in conjunction with other institutions in the town, for the good of the public. Neither of the Medical Schools, it seemed, had much money, and on that account, therefore, he thought their usefulness would be increased by being united.

The PRESIDENT said, he hoped what Mr. Hall recommended would take place, if not at present by and by.

The PRESIDENT directed attention to the subjects standing over for discussion, and asked if any gentleman had any observations to make upon Mr. Longridge's paper which stood first on the list.

Mr. T. Y. HALL said, the only remark he had to make was that made at a former meeting, that the paper was very late in coming before the members. It was read at the December Meeting, and not circulated till March—then with additional notes.

The PRESIDENT said, it was printed in February. He considered the subject well worthy the consideration of this Institute. There were some very good practical suggestions made, well worthy the attention of all practical miners; aud he was sure the Institute was very much obliged to Mr. Longridge for the trouble he had taken in bringing the subject before them.

Mr. HENRY LONGRIDGE said, in a report made in 1845, the subject of compressed air in sheet iron vessels as a means of penetrating choke damp was mentioned, and a small apparatus was exhibited; but it did not appear that anything of the kind, at least that he had heard of, had been carried out in practice. He should be glad to know from any of the members if such an apparatus had ever been tried on a practical scale in Belgium.

Mr. JAS. S. LONGRIDGE said, that since his paper had been written he had seen a paper by Mr. Gouat, who also proposed the adoption of compressed air in metallic vessels as a means of penetrating choke damp; and he had since seen Combe's work which contained a similar proposition. If he had seen these before he wrote his paper he should not have brought the thing forward; but, as it happened, it was a re-invention on his part, of what had been previously proposed. He did not know any reason why it had not been practically adopted. Whether or not it had been tried and failed he could not tell; but he still remained of opinion that its practical application might be of very great service.

But, the point to which he attached most importance, if it were of any real value, was its being applicable to each individual miner. He believed the apparatus might be made in a cheap form, so that each miner might take one with him when he goes into the workings, as he does his lamp. If that were not so, the only benefit to be derived from it would be that of enabling the people at bank to get access to the sufferers after an explosion. It was very much more desirable if the men, instead of being left until some one went into them, had the means of coming out through the dangerous atmosphere themselves, or of getting into places of safety where the compressed air might be stored up.

Mr. Dunn suggested that as Mr. Longridge's paper and Mr. Hall's were upon the same subject the discussion should be taken together.

The President said he thought it very desirable that both discussions should be taken at once.

Mr. Hall said, he had never read Mr. Longridge's or any other paper on the subject before he had prepared his own plan; and he had written to the Secretary, Mr. Sinclair, so far back as August last, stating that if he could find a place he was quite willing to test the principle on the plan he had developed.

The President said, of course it was not to be supposed that there was any rivalry in the matter. No doubt this was a very important subject. They could not have a better illustration of that than the late melancholy accident at Ince Hall. They all, probably, would have heard that there were several men destroyed on one side of a door, while on the other side of it there were several men that were saved. It was of very great importance, especially in so small a distance, that they should have some means of saving life; and it was a serious question for the profession whether or not such an apparatus as had been suggested might be effectual for that purpose. Of course, any new invention required consideration before it was introduced; but he thought both Mr. Hall and Mr Longridge might take it for granted that both papers would receive that consideration from the members of this Institute which was due to the importance of the subject. As the expense of constructing an apparatus, of the kind proposed by Mr Hall, was so trifling, he would suggest to that gentleman that he should fit one up in his own colliery at Townley, and invite the members of the Institute to witness the result. No one was better able to superintend the application of such a plan than the inventor himself.

Mr. Hall expressed a wish that the President or any of the members should provide a place, when he should be very willing to try the experi-

ment; but, after some conversation, Mr. Hall undertook to apply the apparatus at Townley Colliery, where there was plenty of gas for the purpose, and so afford the members of the Institute an opportunity of witnessing its application.

Mr. DUNN proposed to ask Mr. Hall a number of questions which he had prepared in writing, with respect to several points not sufficiently, as he conceived, explained in his paper.

The PRESIDENT having perused the questions, observed that they might be very proper ones, but, being sixteen in number, it was evident they could not get through the discussion of them within any reasonable time that day. He, therefore, suggested that the questions should be handed to Mr. Hall, allowing him to answer them at the next meeting.

This suggestion was acquiesced in unanimously.

The SECRETARY said Dr. Payerne, the inventor of the Submarine Boat, was said to have discovered a substance which enabled some fourteen persons to live together in an atmosphere completely excluded from the external air, for six or seven hours together. The experiments, it was said, had been tried in Cornwall; perhaps some of the member of the Institute could give an explanation of the matter.

The PRESIDENT—Where is Dr. Payerne? Perhaps the best way would be to communicate with him at once.

The SECRETARY said, he believed Dr. Payerne was in France. He had read an account of the experiments in the newspapers, but that was all that he knew upon the subject.

Mr. WALL, of Prescott Street, London, who had attended the meeting for the purpose of affording explanation with respect to boring on the plan of Mr. Kind, said a friend of his who had seen an account of the experiments in Cornwall, which were tried in a diving bell under water, had written in order to ascertain all the information he could upon the subject, when the answer he received was, that the plan was practicable but too expensive.

This terminated the discussion on the subject of Penetrating Dangerous Gases.

The PRESIDENT then directed the attention of the members to the next subject of discussion, namely, Mr. Mackworth's paper on Boring according to the plan of Herr Kind, in Germany.

Mr. WALL explained by reference to models, which he exhibited, the processes of Boring according to the "Systême Kind," and described in the paper read at the last meeting. The models were, of the "Free-fall"

apparatus, the "Core Borer," and the "Core Extractor." The action of the free-fall apparatus is to permit the fall of the chisel to take place without the rods falling with it; the lashing of the rods against the sides of the hole during and at the end of the fall was therefore avoided; the rods had nothing to do but lift the chisel to the necessary height and after its fall follow at a moderate speed and lay hold of it again; they had not, therefore, to withstand the severe shocks as when rods and chisel fall together; they never rested on their lower end at the bottom of the hole, but were always hanging from the end of the lever with which the operation was carried on; and were never, therefore, subjected to other than the tensile strain in lifting the chisel. On these accounts they incurred less risk of breakage and could be of much lighter construction; wooden rods were usually made use of, which were seldom or never broken, except caused by some accident to the overhead gearing, or, where tubing is not used, by a fall of rock in the hole, and even accidents of this latter nature were much less liable to occur under this system, from the rods not striking against the sides of the hole.

The models of the "Core Borer" and "Core Extractor" were alluded to in illustration of the description given in the paper. Care was necessary in the use of these instruments in order to ascertain, with accuracy, the direction of the rise of the beds, especially in raising the core after it had been detached; in order to guard against any error from the twisting of the rods, in raising them, straight edges are fixed on to rods at right angles to their length, which are kept parallel to a string stretched across the mouth of the hole. The system is now in very extensive operation in France, Germany, and Belgium. One of the most remarkable instances is at Homburg, near Frankfort-on-the-Maine, where they had, in September last when he visited it, reached a depth of 1,800 feet, and were going through schist and quartz rock. The hole was lined with an iron tube from the top to the bottom. They had had very serious difficulties to encounter, one of which was owing to a bed of loose gravel, some distance down, which had closed up the hole after passing through it. The object of this boring was to obtain water of a sufficiently high natural temperature to be used for warm baths. It is intended to go 600 feet deeper, when the temperature is expected to reach 95° Fah. In the second table of Appendix No. 2 of Mr. Mackworth's paper, a note has been omitted which is necessary in order to show how the average cost per yard is arrived at. The total expense of the plant to the end of December, deducting 50 per cent. for depreciation, outlay in erection, &c., is divided by the depth bored up to that time, to give the cost for plant

per yard, on the whole depth; this amount is added to the cost per yard in labour due to the boring itself for each month. In the months of September and October, it will be observed, that little or no boring is done while there is still the same outlay in labour on the hole; this was due to an extraordinary accident in a violent storm which overset the bore-house and broke the rods in the hole, together with some other accidents causing delay and expense to remedy; in the deduction to be drawn from this example, therefore, these two months should be omitted, lessening the depth by 11·91 yards, and the expense by £104·82. Further, it is to be remarked that the outlay in plant includes a small wooden house for the residence of the bore master, sheds for smith's shops, and the whole original cost of rods, tools, &c. For a comparison with the old method we may, therefore, say that 285 yards of boring, 12 inches diameter, were executed for £348, expended in labour; as to the rods, tools, &c., there is nothing about them to render the cost but very slightly, if at all, more costly, than is the old method.

The Coal Cutting Machine, by Mr. Waring, of Neath Abbey, formed the next subject of discussion. A beautiful model of the machine was exhibited, and Mr. Waring explained its principles and mode of application.

A specimen of a substance denominated, by Professor Johnson, Hatchatine, and supposed to contain fire-damp in a high state of tension, was exhibited by the Secretary, Mr. Sinclair. It was found by him at Seaton Colliery, in the County of Durham, at a depth of 250 fathoms.

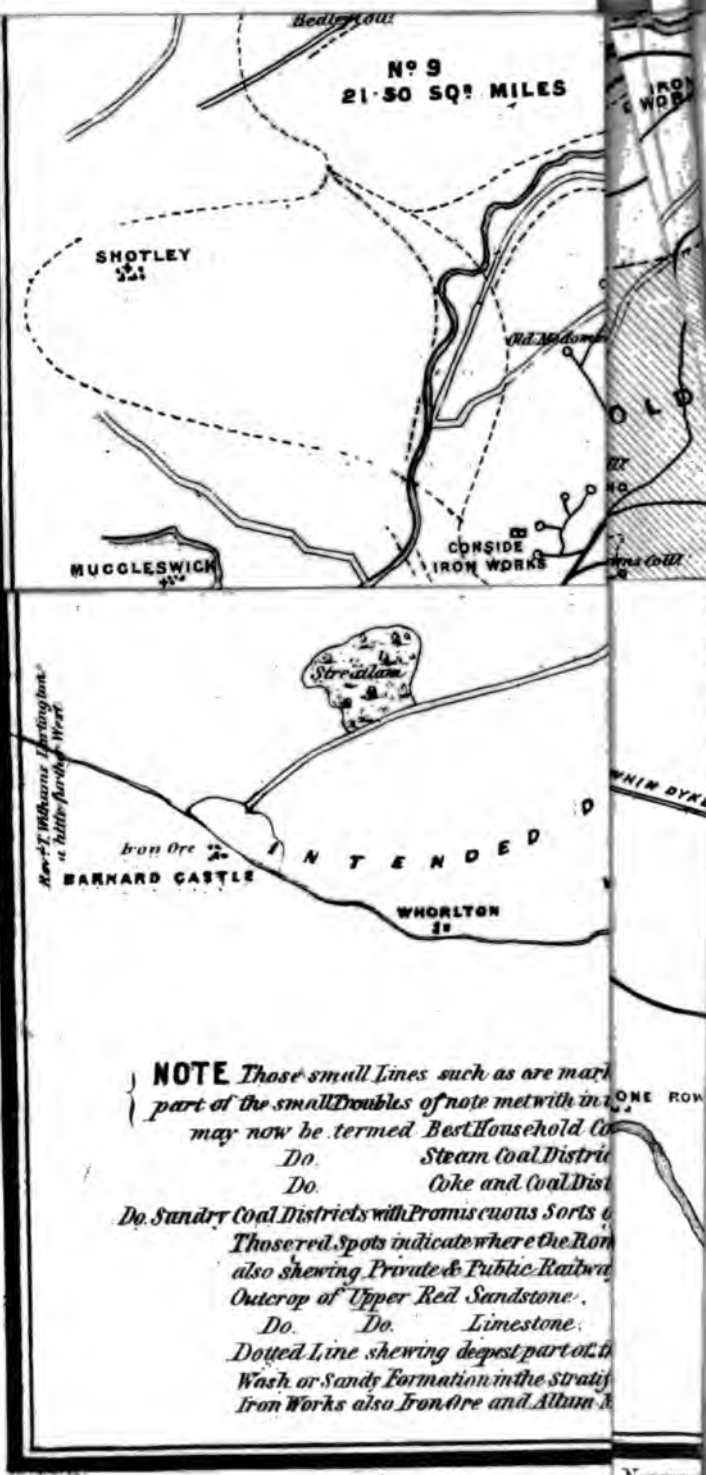
The meeting next proceeded with the reading of Mr. T. Y. Hall's paper on the Extent and Duration of the Northern Coal Field.

During the reading of the paper the President found himself obliged to leave the meeting, and Mr Anderson, of South Shields, one of the Vice-presidents of the Society, occupied the chair during the remainder of the proceedings.

EXTENT AND DURATION OF THE COAL FIELD.

The President observed, that the discussions having been gone through the meeting would now take the papers to be read. There was only one, which was by Mr. T. Y. Hall, on the Extent and Duration of the Northern Coal Field. It was, he believed, rather a lengthy document, but if they could not get through the whole they might read what they could in the time at their disposal, and take the remainder at another meeting.

Mr. Hall, at the request of the President, then proceeded with his paper, prefacing it by observing that he presumed the object of this Institute was to give universal popularity to the views the members entertained, and the improvements that were made, or proposed to be made in our Northern Coal Field from time to time. He deemed it expedient for him, while attempting an exposition of the subject he was about to bring before them, to solicit their attention while he stated, in as concise a manner as possible, his opinions as to the propable duration of the coal field in Durham and Northumberland, and other subjects immediately connected therewith. Mr Hall then handed his paper to the Secretary, who read the introduction and first three chapters of the document, the reading of the remainder being postponed until the next meeting.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THE

EXTENT AND PROBABLE DURATION

OF

THE NORTHERN COAL FIELD;

WITH

REMARKS ON THE COAL TRADE

IN NORTHUMBERLAND AND DURHAM.

By T. Y. HALL,
NEWCASTLE-UPON-TYNE.

INTRODUCTION.

It may be necessary before commencing a rather lengthy paper, subdivided into a great number of sections, on the present state and probable duration of our Northern Coal Field, and other remarkable matters connected therewith, or included within the range of the subject, to mention to the Members of this Institute, that, as many of our most influential members reside in foreign parts, and others at a great distance from the Northern Coal Field, to which we desire chiefly to direct our attention with a view to improvement, it appears extremely desirable that this Institute should possess a large and accurate Map of the Coal District in Northumberland and Durham, accompanied by Sections and Plans, with a written description of the whole, so as not only to render elucidation easy to strangers, but to serve the Mining Engineers of the district as a work of reference and a guide to the future.

The increase of Colleries both in new and old districts, and the manufacture of Iron and Coke, in which a certain description of coal is largely employed, may warrant an extension of this plan a few miles beyond

what may be termed the N.W. limit of the Coal Field, so as to include the North Tyne Coal and Iron Ore district; and also beyond the county of Durham, so as to embrace the rich Iron Ore of the Cleveland district, on the Yorkshire Coast, and contiguous to this long proposed Harbour of Redcar, with its extensive capabilities of improvement.

Having already provided Plans and Sections of the Coal Field, and prepared a long written document on the subject, it is my intention to submit them to the Institute, in parts, or in about Twenty Chapters, under the following heads, (of which the first three are now presented):—Chapter 1.—Situation of the Coal Field; its general character Boundaries, and Divisions. Chapter 2.—Dykes and Faults. Chapter 3.—Rivers and Ports. Chapter 4.—Strata of the Coal Field. Chapter 5.—Colliery Districts and Coal Seams. Chapter 6.—The different Kinds of Coal. Chapter 7.—Coal Formation in the Tyne District. Chapter 8. Districts distinguished by the nature of the Coal they chiefly produce; Household Coal District. Chapter 9.—The Coking Coal District. Chapter 10.—The Steam Coal District. Chapter 11.—Doubtful and bad Districts. Chapter 12.—General Remarks on the Districts. Chapter 13.—Public Railways and Docks. Chapter 14.—The Coal Field in Sections. Chapter 15.—Prices of Coals; how influenced. Chapter 16. — . Chapter 17.—Gross Annual Outlay for Coal Rents, and taking the Coal by Railway, and all other charges to Place of Shipment. Chapter 18.—Estimate of Probable Duration of Coal Field. Chapter 19.—Concluding Observations. Any extra information which any of the members may be disposed to afford me, especially in respect of details which can only be reached through the various representatives of Local Collieries, will be acceptable, and if it reach me in time shall be embodied in the course of the work. And with regard to anything that may seem to require correction or be open to debate, I shall be very happy to hear discussion upon it.

CHAPTER I.

SITUATION OF THE COAL FIELD; ITS GENERAL CHARACTER, BOUNDARIES, AND DIVISIONS.

The accompanying plan of the Great Northern Coal Field, in the Counties of Northumberland and Durham, exhibits the relative position of the several Collieries, and the ports at which the produce of them is shipped; also the cropping out of the Coal Measures, the Magnesian Limestone, and the new or upper and the old or lower Red Sandstone, as traced upon the surface from actual survey; the direction of the principal Dykes, or Faults, by which the strata have been disjointed or broken; and the special districts wherein the various qualities of Coal, at present worked, have been found in the greatest perfection.

This Coal Field is geographically situated between 54° 35′ and 55° 22′ North Latitude, and between 1° 10′ and 1° 57′ West Longitude. Newcastle, the metropolis of the district, and formerly considered a smoky town, but now, with its street architecture of beautiful freestone, one of the finest in the kingdom, being in 54° 58′ 30″ N. Latitude, and nearly 1° 37′ 30″ West Longitude. This district is bounded by the river Coquet on the North, and extends Southward nearly to Hartlepool near the Tees, a distance of about 48 miles. Its extreme breadth is about 24 miles, and its area has been calculated at not more than about 800 square miles. Mr. Hugh Taylor, in his evidence before the Parliament Committee, estimated the area at 837 square miles, or 535,680 acres; while Mr. R. C. Taylor, an American author, in his Statistics of the Coal Trade, adopts an admeasurement of 780 square miles, or 499,200 acres. As representing the superficial area of the Great Northern Coal Field either of the above admeasurement may be admitted; but if applied as the basis of a calculation for determining the quantity of what is termed the workable Coal existing, and the probable period over which the supply will extend without being exhausted, both may be considered open to objections, and liable to reduction on several grounds, as will be satisfactorily shewn in a subsequent portion of this memoir. The writer, as the result of careful measurements, has adopted an admeasurement of little more than 700 square miles, or 448,000 acres, the details of which will be fully exhibited hereafter. Even in a considerable portion of this area southward, where the seams of coal are under both the upper red sand-stone, and

the Magnesian Limestone, also the lower red sand-stone, they are proved so thin as almost to be unworkable.

The lineal boundaries of the Northern Coal Field assume the form of an irregular triangle, one side of which may be described as running from the mouth of the Tees westward to Woodland Colliery, near Cockfield, a distance of nearly 30 miles. The inland side is formed by the escarpment of the Coal westward, and the line of sea-board may be adopted, with special modifications, as the boundary on the east, the junction northward being at a point near to Amble Harbour, at the mouth of the Coquet.

The general boundary, as thus described, is accurately defined upon the accompanying No. 1 plan. Leaving the Tees near to Port Clarence, the boundary line on the south proceeds by the coast to Hartlepool, thence it follows the old Hartlepool Docks and Railway Line, passing through Monk Hesleton Dean, near to Castle Eden Pit, south of Hutton Henry. To make a straight line of boundary we may, perhaps, go not so far south as Wynyard or Newton Parks, thence on by Sherraton, Chilton, the Clarence Railway, to Middridge, East Thickley, Brusselton, south of Witton Park Iron Works, Evenwood, Norword, Cowden, Cockfield Fell, Butter Knowle, and Copley Bent, in the Parishes of Langsack-cum-Softley, where it joins the extreme western boundary. The country beyond that point is mountainous and destitute of workable Coal Seams, but it abounds in rich Limestone Iron and Lead Ores, which are extensively worked beyond and at Allenheads and Weardale.

After forming an angle at Copley Bent the boundary line proceeds in a northerly direction with a slight inclination towards the east, in nearly a straight course to the Derwent, near to Hamsterley Hall, before which it crosses the river Wear below Wolsingham, where Limestone, Iron Ore, and Lead, are met with; thence it proceeds towards Towlaw, a valuable Ironstone district, where extensive Iron Works are established; next to Thornley Colliery and Hedley Hope, and then to Consett, near Shotley Bridge, on the Derwent, at which place we likewise meet with Iron Works on a scale of great and rapidly increasing magnitude.

The raw material for the works at Towlaw and Consett was principally supplied in the locality, but now immense quantities are brought from Cleveland at a cost of about 5s. per ton, for carriage alone, and from other places. There are great facilities for the manufacture of iron at Consett, inasmuch as a very large capital is employed, and Coal suitable for the purpose is obtained close at hand and within twenty fathoms from the surface.

The Coal Seams "crop" out at Newland, and many places along the hill towards the Derwent, putting in again towards the more elevated Crown Woods at Chopwell, Garsefield, Hedley, Stella, Townley, and Mickley, and again cropping out west in the low lands near the Tyne, at Horsley Wood, near Wylam, and Westward Bywell. Thence the course of the boundary is over Prestwick Carr, past Mitford near Morpeth, towards the harbour of Amble on the Sea, near Warkworth, where the Coal measures diverge from the land under the sea, before reaching which the Seams have become very precarious in all directions.

The Coal measures slope or dip from the out-crop towards the sea, from Widderington Castle, on the north coast, to Castle Eden, near Hartlepool, in a south-easterly direction. On the west and north-west, they are bounded by the out-cropping of the underlying Millstone Grit and Mountain Limestone, which, in some cases, causes the Coal to be found in patches, as at Shillbottle, Scremerston, Newton-on-the-Moor, and other places, such as North Tyne, Acomb, and Stublick.

The lowest Working Seams of Coal are at Monkwearmouth pit, under the Limestone, where the shaft, which is about one mile distant from, and 100 feet above the level of the sea, has been sunk to the depth of nearly 1,700 feet to the Hutton Seam, below which, as usual, will be found the Beaumont—Harvey or Townley; Five-Quarter, Stone Coal, Three-Quarter, and Brockwell Seams.

These Seams have been worked in many of the westward Collieries, for both Sea and Landsale use, and are considered to be the lowest workable seams of the Coal formation.

The Seams of Coal, east of Monkwearmouth, under the Hutton Seam, which is the first workable one there, lie also at a considerable distance below the level of the sea. Westward near the Wear, at Pease's West Pits, the general out-crop of these same seams is at a considerable height above the level of the sea. The same thing occurs near Wylam and Bywell on the Tyne. The inclination, or rise of the Coal measures westward, is at the rate of 92 feet, or 15 fathoms per mile. In the Mountain Limestone, and in some places within the Coal Measures, westward, the Iron and Lead Measures make their appearance.

Besides the general out-crop of the Coal Measures westward, several of the Seams appear at the surface in the great valleys of the Tyne, the Derwent, the Team, the Wear, and the Tees, probably caused by denudation of the surface.

CHAPTER II.

DYKES AND FAULTS.

The strata of the Coal District are extensively fractured and displaced by Dykes or Faults, which run across the country in a direction nearly parallel to each other from east to west. The principal of these is known by the name of the Ninety Fathom Dyke. It runs from near Cullercoats in the direction indicated upon the plan by a strongly marked red line, passing about four or five miles northward of Newcastle, and in all probability going to the Western Ocean. The Coal strata on the north side of this Dyke may be traced for twenty miles, thrown downwards from sixty westward to one hundred and fifty fathoms eastward near the sea, and hence the name by which this great Fault, or slip in the strata, has been distinguished.

The Ninety Fathom Dyke may be traced at Whitley, Killingworth, Kenton, Denton Hall, Lemington, Stella Hall, Stevens' Hall, Greenside, Kyo, East of Coal Burn, South of Minstereacres, and through the Lead Mines belonging to W. B. Beaumont, Esq., M.P., towards the Western Ocean.

It has been drifted through at Shire Moor, and from the south to the north side at Gosforth, Bell's Close, near Lemington Iron Works, at East Townley, Stella Colliery, and West Townley Colliery, about half a mile west of Greenside, on or under the road from Greenside to Coal Burn.

The Drift at Bell's Close was commenced by Mr. Christopher Bedlington, Agent to the Montague Family about seventy years ago, and hence it is called "Kitty's Drift." It was intended to cut several Seams of Coal in the neighbourhood of Kenton, on the level it was commenced at, which was very little above that of the Tyne at Bell's Close; it was likewise intended to use it as a horse way for the purpose of bringing the Coal and Water out on the level without incurring the great expence of sinking a shaft and drawing the same up by an engine, a mile northward of the Dyke. It was known that for a considerable distance the Seams

of Coal, even north of the Dyke, had been worked above the Tyne level, and it was known that unworked Coal Seams would still be found further to the Dip, where this level road was intended to end, and north-eastward beyond these same seams to the rise.

On reaching a certain point, however, after many years of tedious labour and the expenditure of a large sum of money, it was discovered that, in consequence of faults and troubles, the Coal Seams were thrown downwards to the north about forty fathoms below the level of this Drift, and could not be reached in the way contemplated. Some time after this, pits were sunk to the Coal north of the Dyke; and the water from them is at present pumped into "Kitty's Drift," through which it is discharged into the river Tyne. This is a remarkable instance of the misadventure and miscalculation of Mining Engineers in former times, and many of more recent date might be enumerated.

It may be remarked that it was in this district that iron bars were first used as edge rails for tram or railroad carriages. Benwell, in the same neighbourhood, was probably the first place where Coal was worked in Great Britain.

It is somewhat singular that it was on Wylam Colliery Railway, which terminates at Lemington, near this spot, that locomotives were either first or very early used on metal rails of various forms of construction to suit the rough and rugged road existing at that day. Their engines had wheels constructed to suit the rails; these wheels and rails have since undergone changes, having been three or four times re-modelled till they have become what are now generally in use on all best railways.

In the village of Benwell, which is pleasantly situated on the North bank of the river Tyne, and commands a view of picturesque country for several miles to the South and West, up the valleys of the Tyne, Ravensworth, Team, and Derwent rivers. The remains of my late friend, Mr. John Buddle, are interred in a vault, constructed during his life time, in the escarpment of a Coal Seam on the South side of the church-yard. Appropriate locality for the last earthly resting place of one who had devoted a long life to the interests of the Coal trade.

Several centuries ago Coals were conveyed in carts from Brandon near Brancepeth, and the late Lady Peat's Collieries at Thornley Common to Iron works then established on a small scale upon the Tyne and Wear. The distance was upwards of twenty-four miles, and several pits where good Coals were worked had to be passed in making the journey. The reason why coals from the more distant pits were selected over others that might have been obtained

nearer, was, no doubt, their being found preferable for the purposes to which they were to be applied. This fact proves that, even at that early period when the Coal and Iron trades were in their infancy the parties engaged in them had discerned and appreciated the quality of Coal best suited for such manufacture. It is fortunate for the Iron Manufacturers of the present day that they can obtain ample supplies of suitable Coal on so much more favourable conditions than their predecessors did.

A considerable Basaltic Dyke, visible on the surface at Brockley Whins, proceeds thence across the Tyne at Walker, through Byker Bar, the Town Moor, by the West Gate to Kenton, where it meets the Ninety Fathom Dyke, on the north side of which it makes its appearance in two divisions a mile apart. The southernmost division runs from East Kenton Hall, taking the course of the Roman Wall, to Heddon-on-the-Wall, near which village we find even upon high ground the escarpment of the lowest Seam of Coal.

The northern division passes through Coley Hill, where it is 24 feet in thickness, and is worked in quarries for the purpose of road making.

Five or six other Basaltic Dykes intersect the Coal Field at various places in Northumberland, to the north of the Ninety Fathom Dyke. Two of them run parallel about half a mile apart, from Hartley to about a mile north of Cramlington. Two others run westward from the sea near Blyth, one on each side of the Harbour, about a mile and a half apart. These are all nearly parallel to each other, and also to the one previously described from Brockley Whins to Coley Hill. Another Basaltic Dyke near to Radcliffe colliery runs about east and west. At this point from the Sea westward, the Coal Field is only about four miles in breadth. Three miles north of Radcliffe is Amble Harbour on the Coquet, where this outcrop of Coal enters the Sea.

The Heworth Dyke extends from the Sea, south of Jarrow, by Heworth, Swalwell, Axwell Park, west of Stella, to Stevens' Hall, where it disappears in the Ninety Fathom Dyke. On the North or opposite side of which, and nearly in a line with the Heworth Dyke, a similar Dyke runs close by the house occupied by the agent of the Townley Colliery, at the west end of Ryton Bar Moor, and north west through Crawcrook Fields. It then crosses the Tyne, under the house in which the late eminent Engineer, George Stephenson Esquire, was born, about half a mile below Wylam, enters the Rift Estate, and continues through the Wylam Estate to Horsley Wood, where the Brockwell seam of Coal, there called the "Crankey," and sometimes the "Horsleywood Seam" terminates at the

surface. This is the lowest workable seam in the Coal Series, and it takes its name from its coming to the surface at Brockwell Woods, in Blaydon Burn, below Barlow.

The Hett Basaltic Dyke in the County of Durham traverses the Coal Field from Easington, between Shotton and Haswell Collieries, also between Thornley and Ludworth by Hett, between Sunderland Bridge and Ferry Hill, close by the North end of the village of Tadhoe, crosses the Wear, and is seen a little North of the Willington Colliery near Brancepeth, apparently running into the Butterknowle Slip Dyke; and also further westward, those two and the Cockfield Fell Basaltic Dyke would appear to come to a point altogether, and thence on towards the Western Ocean. The Hutton Seam of Coal, on the south side of this Dyke, is much thinner and more expensive to work than the same seam on the north side of it, and particularly in the eastern portion of the district. This Dyke may be traced considerably beyond the out-crop of the Coal at Witton-le-Wear, beyond which place it runs nearly parallel with the out-crop to Woodland Colliery, a distance of nearly six miles. This colliery is situated about two miles to the south of the Hett Dyke, at the extreme out-crop, and at about the same distance northward from the Cockfield Fell Dyke. These three Dykes approach each other as they proceed westward; the reverse is the case as they go eastward, the Hett Dyke running into the sea near to Easington, the other, Cockfield Dyke, running between great Aycliffe and Darlington, close to Roseberry Topping on the south and into the sea at Whitby. In the same manner that the Hett Dyke deteriorates the quality of the Hutton seam southward of it, does the Cockfield Fell Dyke deteriorate the quality of the Iron-stone to the south of it, as particularly observable in the neighbourhood of Roseberry Topping.

The Hett Dyke has been drifted through at Shotton, which pit was sunk by the Haswell Company on the south side of the Dyke for the purpose of working a good Five-Quarter seam, and also in expectation of meeting with the Hutton Seam in good workable condition. The Haswell pit had been sunk previously north of the Dyke, into a good Hutton Seam, the produce being shipped by Durham and Sunderland Railway at Sunderland, and it was intended to convey the Coal south of the Dyke from Shotton Colliery by the Hartlepool Railroad to Hartlepool Dock for shipment. When the Hutton Seam was sunk to at Shotton, it was found to be very inferior in consequence of its being tender. The five-quarter was therefore mainly resorted to, and the proprietors afterwards bored or sunk

to the Beaumont or Harvey Seam below the Hutton. They then made a drift in the Hutton Seam to the Hett Dyke, which they found to be of great thickness, and very hard, and after much labour and expense they pierced through it into the good Hutton Seam, on the North side, thus enabling a direct underground communication between the Shotton and Haswell Collieries to be made at some future day, and so admitting of the good Hutton Coal being brought through a long lead in this underground drift, up the Shotton Pit, and led and shipped along with the Five-Quarter Seam at Hartlepool.

The quality of the Hutton Seam on the South side of the Hett Dyke had been proved previously to this by another proprietary, the Thornley Company, who, in consequeuce of its thinness, limited the workings to the Five-quarter; and subsequently sunk to the Beaumont or Harvey, which they found to yield good coking coal. The Thornley Company being in possession of a large district North of the Dyke, drifted up to, but did not at that time attempt to cut through the Dyke, but sunk another pit at Ludworth, where they found the Hutton Seam in excellent condition, which they now work extensively. The coals from Ludworth and Thornley Colliery being sent to Hartlepool Docks.

The Hett Dyke was likewise cut through at Willington, near Brancepeth.

The Butterknowle Forty-fathom Slip Dyke is seen at the Cockfield Fell, a little west of Cockfield, and proceeds by Thrislington, Bishop Auckland, Ferry Hill Station, and near Monkhesselton, to the Sea. It runs parallel to the Hett Dyke throughout its course, at an average distance of about three miles to the South of it. This is a Slip Dyke and not a Basaltic one like those of Hett and Cockfield Fell, but like the Ninety-fathom Main Dyke, also Heworth Twenty-five-fathom Slip Dykes.

There are several small Dykes and Slips met with in various parts of the Coal Field, running in different directions, as shown upon No. 2, a similar plan to No. 1, and they too also appear to be of sufficient importance to call for minute description, which will be on a large plan. The small Dykes as well as the large ones cause great expense to Coal Owners, as they interrupt the working of the coal very materially.

The present paper being foreign to the purpose, it is not necessary to express any opinion as to the formation of these extraordinary phenomena, further than that it would appear some great force has occurred throwing the stratified crust of the earth down in some places, and up in others. And, as regards the Basaltic Dykes, there would seem to

have been a severance of the Strata in a vertical or sloping direction, in many places several yards apart, and the intervening space to have become filled with Basalt while in a state of fusion from intense heat. At Cockfield this severance extends to about 22 yards; it is greater at Shotton and westward. At Willington, near Brancepeth, not so difficult to penetrate as at other places.

The fact of the severance having become filled up with Basalt in a state of fusion is evident from the circumstance of the coal in some places on both sides of these Dykes, having been found charred, or converted into coke by the agency of heat, and deteriorated from other causes.

At Stella Pit we next met with a coal, which when burnt in a coke oven for 150 hours does not change its appearance. In certain districts, also, the quality of Coal in the neighbourhood of these Dykes is found to be deteriorated, from what cause has not been satisfactorily ascertained.

A similar deterioration, as before remarked, occurs with respect to the Iron-stone.

A peculiar Dyke, or Fault, is found running in a direction North and South, extending from near the City of Durham to the Team and King's Meadows, on the Tyne. It is 27 fathoms in depth in some places, and is filled with alluvial deposits, pointing in a direction towards Norwood Colliery on the Team Valley and through Ravensworth Park.

CHAPTER III.

RIVERS AND PORTS.

The Ports at which the produce of the Northern Coal Field is shipped on the Eastern coast of England are Middlesbro' and Port Clarence on the Tees, East and West Hartlepool, Seaham, Sunderland, Newcastle, Shields, Seaton Sluice, Blyth, and Amble near Warkworth.

Redcar, about four miles South of the Tees, though not established as a port for the shipment of coals, has lately risen into importance in consequence of its proximity to the Cleveland Hills, which abound in valuable Iron-stone, in beds of from 10 to 16 feet in thickness. A railway unites Redcar with Middlesbro', where it joins the Stockton and Darlington Railway, and branches are formed from the Redcar and Middlesbro' line to Birdley Moor, Eston Nab, Roseberry Topping, Birnaldby Moor, Guisbro', and Cod Hill, and Iron-stone Deposit at Huncliffe and Redcliffe, on the Sea Banks. Extensive Iron-stone workings have been commenced by various parties in this important district, the produce being conveyed by railway, or shipped at Redcar, and by branch railways to the main line and to the different places where furnaces have been established for smelting the same. The principal parties engaged in this rapidly extending branch of trade, are Mr. Pease, who leases a considerable district, including Roseberry Topping, round which he proposes to form a railway, for which he has already obtained an Act of Parliament; Messrs. Bolckow and Vaughan, who have extensive Iron Works at Middlesbro'; Bell, Brothers, at Port Clarence, on the opposite side of the Tees; Baring Brothers and Co., at Towlaw, on the Wear; and the Consett Iron Company, who have a large establishment near Shotley Bridge, on the Derwent, and there are also sundry other parties on the Tyne.

About twenty years ago, I went with Mr. Brooks, now Engineer to the Commissioners of the River Tyne, to examine and report upon these valuable Iron ores, as may be seen in the report made by him, when Engineer for the River Tees, and published in the Nautical Magazine for May, 1833.

g the publication of this long and valuable report, call-
, the subject generally and to the immense beds of iron
at time until very recently, only two or three years ago,
e was taken of that which has since turned out to be so im-
. Mr. Brooks, at the period referred to, suggested the formation of
arbour at Redcar, not only for mercantile purposes, but as a Refuge
or Ships of War, and Merchant Vessels, in stormy weather. The projected Harbour comprised an area of 450 acres, admirably situated, and sheltered by rocky promontories North and South, with a depth of twenty feet at low and forty feet at high water. This magnificent scheme might have been carried out at comparatively little cost, on account of the facilities of formation afforded by the locality itself; had such been the case, Redcar would have been a very important place long before this time; but it has been allowed to slumber. It is still of more importance than ever, if even something as good is done of the like nature elsewhere, as both would materially assist even at the Tees, Hartlepool Dock, but more particularly the River Tyne, as it is the deepest tidal water, and the transit to and fro, by sea, would be exceedingly regular and cheaper than anywhere else upon heavy material, such as Coal and Iron Ore.

The Tyne, also the Northern and Western District of our Coal Field, especially with the immense improvements now going on in the Tyne, would derive immense advantage from the construction of the proposed Harbour at Redcar, in consequence of the distance being only thirty miles, and screw steamers could go to and fro in a few hours and bring the ore to the Tyne for 1s. 6d. per ton to Coal on the spot of a quality extremely suitable for the manufacture of Iron. The Coal is at present conveyed by the Stockton and Darlington Railway thirty-six miles to the Docks at Middlesbro'. If the furnaces are there the stone must be brought from the places where they are quarried in the hills, by rail either near to or to Redcar, and other places to meet the coal at the furnaces; making the distance for land carriage before the two articles and the Limestone meet about 45 miles. In case the furnaces were erected at or near Redcar, Middlesbro', or Port Clarence, the distance for land carriage would not be diminished. But, were the stone brought from Redcar by sea to the Tyne, where the best Coking Coals are worked upon the spot, full two-thirds of the cost of carriage would be saved, besides other advantages. Assuming that three-and-a-half tons of Iron-ore, with less than one ton of Limestone, will make one ton of Pig Metal, five tons of coal are required for the purpose of manu-

facturing it into Pig Metal, and two tons extra coal to make it into Bar Iron. Two tons of good Coke are equal to five tons of Coal in the manufacture of Pig Metal; so that by using Coke instead of Coal, notwithstanding a little less cost for carriage, the saving might be much greater. From this data a calculation can easily be made of the advantage to be derived from bringing the Ore to the locality where the Coal, Coke, and Limestone can be obtained upon the spot, or with only a short lead of a mile or two.

Upwards of twenty years ago, Stockton was the principal shipping place for the Auckland Tees Coal District, with which it was connected at that time by the Stockton and Darlington Railway, which was subsequently extended by a bridge, (which was first a suspension bridge, but when that form of construction did not answer for Locomotive and heavy trains, a stone and iron bridge was built) across the Tees to Middlesbro', on the Yorkshire side of the river, where shipping places with descending drops to put the coal from the waggons into the ships, and a spacious dock have since been erected. Stockton, as a shipping place for coal, has greatly or nearly altogether fallen off since that period although the Tees river tidal water has, even at that place and elsewhere, considerably improved and straightened the mouth of the Tees.

About the same time, or shortly after that the shipping places at Middlesbro' were established, Port Clarence, on the opposite side of the Tees was brought by the formation of the Clarence Railway into connexion with the Coxhoe, Byers-green, Ferryhill, and Chilton district. Branches have been formed with the Clarence from Stockton to Hartlepool, and also Thirsk and Leeds and from the Clarence line to the Stockton and Darlington Railway at Simpastures, Bishop Auckland, and Wear Valley, and from Ferryhill to Byers-green, and other places westward. There are other connexions between the Clarence across the Tees, to the Middlesbro' side contemplated, if nothing better can be invented to cheapen the present round-about carriage. All those works have contributed to change the aspect of Trade upon each side of the Tees, very materially during the last quarter of a century.

The next port North of the Tees is East and West Hartlepool, a safe and commodious harbour accessible in all weathers. Spacious docks have been constructed here within the last 20 years and are connected by Railways with the neighbouring Coal Fields, and also with the Iron Stone district of Cleveland. The old Dock is connected by a Railway with Thornley, Shotton, Haswell, and South Hetton, having also a branch from

it by Castle Eden, Wingate, and the Trimdons, Garmonsway Moor, Cassop Colliery, to the Byers-green and other branches from Ferry Hill where the York, Newcastle, and Berwick Railway crosses underneath it. Hartlepool West Harbour with the Railway joining the Clarence, from Stockton to Hartlepool also forms an important part, each with a junction at Ferry Hill. These railways unite with the Stockton and Darlington, and the Leeds and Thirsk Railways near Stockton, and the York, Newcastle, and Berwick Railway at Ferry Hill, to Byers Green. &c., and the West Durham Railway to Bishop Auckland, &c.

The East and West Hartlepool Docks are in the hands of rival commissioners so that the port charges have always been moderate. They are so, at the present time, and are likely to continue so.

At Hartlepool there is one of the best lighthouses in the North of England, and every facility and accommodation are afforded to vessels visiting the port.

Ships of twenty feet water and upwards at extra high tides are able to load in the Dock. The lighthouse, which embraces many novel features, amongst others the Dioptric Lens Light, the only one in this part of the country used for such a purpose, was erected under the direction of the Government, ten or twelve years ago, by Stephen Robinson, Esq., Civil Engineer, Hartlepool.

The next port Northward is *Seaham*, constructed at an enormous expence, by the late Marquis of Londonderry, of whose public spirit and commercial enterprise it constitutes a conspicuous monument.

The valuable and extensive estate of Seaham, rich in mineral treasures, was purchased by the Noble Marquis from Sir R. Noel, formerly Milbank, about thirty years ago.

Shortly after obtaining possession of the property, his lordship commenced the construction of a harbour at Seaham, with the advice of Wm. Chapman, Esq., Civil Engineer, who had previously designed the first plan, and his chief agent, the late John Buddle, Esq., of Wallsend, who afterwards made many extensions and great improvements, and whose name will ever be honourably associated with the Coal Fields of the North of England.

The locality presented many formidable obstacles to such an undertaking.

The sea-board was by no means favourable. It was necessary to excavate the Limestone Rock, which here forms the ocean barrier, and public opinion generally pronounced the scheme, if not impracticable, an

unprofitable and bold undertaking. In making the first experiment at excavating, when many thousands were assembled at the opening ceremony, a conical pinnacle of rock, weighing thousands of tons, was fired with gunpowder and blown into the air. The Marquis and his Agent (Mr. Buddle,) fired the shot, retreating into a creek during the explosion, while the Marchioness witnessed the scene from an adjoining height, in company with an immense assemblage of people, the rock blew up and fell and several of the people were injured. Year after year the noble Marquis pursued his laudable object, undaunted by difficulties, as in every thing he undertook, which would have dismayed ordinary minds, he surmounted every obstacle, and now a populous and prosperous port and town, the convenient outlet of an extensive and valuable Coal district, justify the foresight of the noble Marquis, and his Manager, John Buddle, Esquire, and enable us to appreciate their sound judgments, spirited enterprise, and dauntless courage.

As an individual, undertaking the construction of Seaham Harbour, he stands without a parallel in this country, except at Cardiff, in Wales, where the like might be said of the late Marquis of Bute in making Docks and Harbour at that place.

The Coal wrought from his own royalties, which are very extensive, independently of those which he holds under the Dean and Chapter of Durham, and others, and shipped at Seaham, also the Tyne, the River Wear Drops, the Sunderland Docks, to which they are contiguous, yet Seaham yields sufficient revenue for interest in Port Charges to maintain the Harbour in an efficient condition, and defray the cost of necessary improvements, so that, as a private undertaking the expenditure of capital has been judicious and remunerative at last.

The shipments are not confined to those of the late noble Marquis only, which were considered to be far more than he could ever make accommodation for, but they embrace the coal produce of the Grange, North and South Hettons, Dalton, and two Seatons, extensive collieries belonging to the Marquis and wealthy Companies, many of them having railways of their own, and, it is probable that in a short time, other collieries will be brought into these arrangements for part of the accommodation they require. Overtures with that object were made to the Proprietors, and his Lordship offered to extend the present, and lay down a new railway.

The Coal under the Seaham estate comprises the justly celebrated Hutton Seam, which is deservedly held in high repute; next to Seaham and Seaton are Silksworth and Ryhope Royalties, also in good repute.

Not only are the present working Collieries of the late noble Marquis sufficient of themselves to sustain the prosperity of the port of Seaham, but there are extensive Royalties in reserve, not only belonging to, but under lease to the late Marquis and others, viz., Earl of Durham, Haswell, Great Hetton, South Hetton, and two Seatons, and for which they have paid in "Dead Rent" several thousands annually, amounting to upwards of £150,000, and if interest were taken into account another £100,000 might be fairly added, making something like one quarter of a million for five parties only, that are ready to work out the same whenever they think it profitable and desirable to do so.

The aggregate of "Dead Rents" paid by various parties in the Counties of Northumberland, and particularly Durham, in this way, and must continue this apparently profitless expenditure for many years to come, in order to carry out the object for which they embarked in such a course, which must still add greatly to their capital embarked. There are no means readily accessible for ascertaining the aggregate amount of "Dead Rents" paid annually in those two Counties, but, judging from facts which have from time to time come within our own knowledge, the aggregate now paid may be taken at more than double the amount named. The gross amount at present paid annually is about £360,000. A further amount of £150,000 or more may be said to be paid also to landlords for surface wayleaves.

The object of such payments is obvious, they constitute a large item in the expense of maintaining, not a monopoly of Coal districts, but reserving to each Coal Owner sufficient territory of Coal equal to the capital they have employed for the plant and railroads and other stock, by keeping enterprising individuals, and especially small proprietors, out of the best field or Coal Districts.

Proceeding Northward from Pensher, we reach the flourishing Port of Sunderland, situated at the confluence of the River Wear with the Sea. This port is the largest in respect of tonnage in ship-building of any in the United Kingdom, or even in the World. There spacious Docks afford accommodation to vessels of the largest class, where they may ride in safety in the most tempestuous weather. The entrance at the south side will soon be finished.

Coals are extensively shipped at this port, besides various articles of general merchandise, Iron, Lead, Glass, and Earthenware, are the chief articles of export besides Coal; and its imports beyond Timber, Hemp, Tallow, are comparatively insignificant. The River Wear flows through a large portion of the County of Durham, but is only navigable in small

craft above Hylton, or rather for ships to Southwick, and Victoria Bridge, which is about seven miles west of the sea, above the beautiful Cast Iron Bridge, of a single span, resting upon rock abutments on both sides, built upwards of fifty years ago, by the late Rowland Burdon, Esq., a name familiar as a "Household Word" in the Colliery districts of the Tyne and Wear.

There is little to relate of Sunderland beyond what may be found in any hand-book, or directory of the place. The town is united by a branch railway, which goes through a Coal Field, already taken up, to Pensher, on the line of the York, Newcastle, and Berwick Railway, and it also possesses railway communication with East and West Hartlepool, Durham, Stockton, Darlington, Monkwearmouth Dock on the north side of the Wear, and Railway to Stanhope in Weardale, and various parts of the county in which it is situated, and which, perhaps, more appropriately than any other in the United Kingdom, may be described as being "girded with railways." Monkwearmouth, belonging to Sir Hedworth Williamson, through his liberality of granting long rented leases, is becoming an increasing important place for ship building on this side of the Wear, and factories, dwelling houses, &c., and the Newcastle Railway ends here, and also at the North Dock.

The late Marquis of Londonderry, at the time of his death, independent of the one that he has from Rainton and his Collieries, to Seaham, was constructing a railway of his own between Seaham and Sunderland, with a view of shipping a portion of the produce of his extensive Coal Fields in the capacious docks near the South entrance of that harbour. This work is still in progress. For these docks the inhabitants of Sunderland are almost wholly indebted to the wonderful enterprise of one man, George Hudson, Esq., one of the Parliamentary Members of the Borough.

The Hetton Coal Company and the Earl of Durham have each railways of their own to the Port of Sunderland, on the River Wear, and ship coals to a large amount every year. The Monkwearmouth Company on the South side of the Wear have also shipping places opposite these of their own; also Coals are shipped in the Docks at Monkwearmouth and Bishopwearmouth. Usworth and other Pits work coal and ship the same at the North Dock, also the South Dock at Sunderland Moor, to which places they are conveyed by Public Railways, belonging to the York and Berwick Railway Company.

The chief Port upon the North Eastern Coast of England comprising the limit of the Northern Coal Field above described, is undoubtedly the

Tyne, recently subdivided into the Port of Newcastle, and the Port of Shields.

The *River Tyne* forms the natural division between the Counties of Northumberland and Durham, for the two Coal fields through it is not in all places their Topographical boundary. The town of Newcastle is situated on the North Bank of this River, about nine miles from its confluence with the German Ocean, and, as already stated, has long been regarded as the Metropolis of the Northern Coal Field, a distinction to which it is entitled, as well for its antiquity, the conspicuous position it occupies in the history of the district, the number, intelligence, and wealth of its inhabitants, and the large extent of business operations carried on within its precincts, as well as from the peculiarity of its situation in the midst of those material elements, which have essentially contributed towards the development of the industry, wealth, and greatness of the British nation.

The River Tyne affords excellent shipping berths for vessels of a large class, there being deep tidal water nearly all the way from the bar at Tynemouth, through the Port of Shields, up to the spacious Quay at Newcastle.

This Quay was enlarged a few years ago, at the sole expense of the Corporation in order to meet the requirements of an extending trade, and improvements on a scale of great magnitude are also contemplated at the mouth of the river. Mr. Walker, in his Report of 1854, recommends that extensive Piers should be erected both on the North and the South side of the entrance to the river.

There is plenty of tidal water for vessels, West of Newcastle, up to Blaydon and Stella, still in a more valuable Coal Field, but at present the navigation is greatly impeded by the Old Tyne Bridge, with its numerous low narrow arches, and also by a throw up, or stone dyke, which crops the river below Lemington. Both these obstructions cripple the tidal flow; one by narrowing the channel, the other by lessening its depth, and never altering on account of its being rock. In neap tides the navigation near Lemington, is altogether stopped, in consequence of there being so little water upon the rock, which has been unaltered since before the time of legal memory, but which could easily be removed. Westward of this rock, for a mile, the soft bed of the river is scoured to a depth of nearly twenty feet, but the river again runs shallow further west. At Blaydon Burn foot, where it is too wide and dammed back by deposits in the river, and by an old quay, of no use to any one for the last thirty years, which might be blown up in a day and carried away with the tide, and be deposited where the water is twenty feet deep, never to be heard of more. The bed of gravel might be easily removed out of

the river from Blaydon Burn foot, and the navigation is not required much further up the river at present, but, still, further westward, several minor obstructions occur. At my suggestion the late T. G. Dunn, Esq., Chairman of the then River Committee, also Mr. Brooks, then Engineer to the Newcastle Corporation, has since commenced removing the upthrow of stones near Lemington, which has already improved the navigation, both there and at other parts below. There are a few points below the Derwent also rendered difficult by the injudicious width of the river in some places.

It is probable that the old bridge across the Tyne at Newcastle, will be removed shortly, since better accommodation is now offered by the stupendous High Level Bridge, erected by the York, Newcastle, and Berwick Railway Company, after the design of R. Stephenson Esq., M.P., the celebrated Civil Engineer, who has combined in this magnificent structure, the highest degree of Architectural skill, with noblest emanations of Mechanical Science. This bridge is without parallel in the world, and after the ancient structure, which was demolished by the great flood in 1774, and since rebuilt, shall have been swept away by the onward tide of civilisation, it will admit the passage of vessels of the largest class, which may then proceed five miles westward to Blaydon and Stella, thereby benefitting the Commerce of the Tyne, which has public railways on both sides of it, and as there is an enormous extent of the very best Coke, and Coking Coal, suitable for Iron Ore Furnaces, Gas, Coke, &c., there within two or three miles of one of the best shipping rivers, for Coal, in the world, we may now, perhaps, expect improvements.

The banks of Coaly Tyne exhibit an interesting subject for contemplation. They are studded with Manufactories. Scarcely a span is there to be found without its hive of industry in continued operation.

The Smelting of Iron Ore, and the Manufacture of that Metal, are carried forward upon a large scale in several extensive Establishments on the Tyne, of long standing. Their chief supply of Raw Material is not derived from the immediate locality of the Work, but from Cleveland, Scotland, and Cumberland. The expense of transit, however, is amply compensated by the proximity of the locality of Manufacture to the Coal Field.

The same remarks apply to Manufactories for Steam Engines, Foundries, Alkali, Acids, and Soda, Potash, Glass, Lead, Soap, and Fire Brick, Earthenware, and Grindstones, which are here conducted upon a scale of great magnitude. There can be no doubt whatever, but that the cheapness of labour and of suitable good cheap Coal, Coke, and Water, and the facility of obtaining it, are the principal elements which have con-

tributed to attract capitalists to select this locality for the seat of the Manufactories above described, and as a Central Local Seat, it is now much more appreciated than ever.

Within only a recent period, there have been several Establishments founded for Builders of Steam Screw, and Iron Sailing Vessels, a branch of industry in which the Clyde has for some time past, and does now, largely participate.

The facility afforded for the Manufacture of Iron, made almost on the spot, with little carriage has contributed to this result. But what has been the chief element of Tyneside prosperity? The abundant supply of cheap Labour and of Coal, Coke, and Water of the best quality, at the cheapest rate, which has been, and will continue to be supplied to those who require them. For miles the land and water embrace each other under a canopy of Coal Drops. The River Termini of Railways originate at shafts or deposits, far away inland, and many miles separated from each other. Most of the Collieries which work Coal on the Tyne, however, are either close to or within a moderate distance of that noble river; yet, it is worthy of remark, that the greater part of them, close to on both sides, have not been successful for the last twenty years; certainly before this period, one particular instance may be worthy of remark. Wallsend, within half a mile of the river, while working what is called Wallsend Main Coal Seam, was so prosperous as to add greatly to the wealth of its proprietor, and identified its name with the "Black Diamond," not only in the Metropolis of England, but in every Coal Mart of the world, but when that portion of this valuable Coal Seam was exhausted, about thirty years ago, this Colliery, or the same pit, was sunk in 1824 to, and worked with the Bensham and the other coal seams below this, sank to the level of the others of the like sort in the same district. It was given up in 1831; now remains carried on by other parties to the present day, struggling on the same par, or even lower. This is one instance of an owner, who, some forty years after the year 1780, having made so bold and wise a stroke at that date, as to sink a pit at so great expense, and hazard so large a stake as nearly to exhaust a moderate fortune, as is generally the case, before any returns. However it did get under-way with coal working that year, and for ten or fifteen years sold coals at about six shillings per ton. After that, for forty years or so, the prices got much higher, making the fifty years from the commencement to when it came into other hands, after which little competition existed for about forty years. It may now not be out of course to state that I heard the agent boast that, while exhausting this

valuable seam, over about forty years, by working two million chaldrons, or equal to five millions three hundred and fifty thousand tons, he realized the large sum of ten shillings per chaldron, or one million sterling in gain. This was an excellent household coal at that day. During the year 1786, one pit was on fire, and only worked that year 4000 chaldrons; the same year they put up a Bolton and Watt steam engine at the C pit; and it is worthy of further remark that the said Owner, at that period of time, bought large estates in the Western part of the County of Durham with part of his profits, and left a memorandum before his death, which event took place some time after, that this territory might come into profitable play in fifty years time, as it had several fine workable seams of coal under the same, not of the like quality as Household at Wallsend, but of a different though finer quality, as to be suitable at the present day for coke and gas purposes, for which there is now an immense demand; and this district, so valuable, is now coming into play as one of the most valuable of our coke-coal districts. The results realized at present, and in prospect, will amount to an immense sum yearly for the present proprietor, and quite possibly make, over the same number of years as above alluded to, an amount similar to the large amount already named.

The superior quality of the Wallsend Coal for household purposes that was yielded from the Wallsend Mine at that time, was a great portion of the high-priced or best coal at that day required, and gave it a most decided advantage in the market over many others of a more tender description. It, like a few others, at that time, such as Percy Main, Whitley, St. Hilda, Jarrow, Walker, Hylton, St. Lawrence, the two Elswicks, Fenham, Benwell, &c., who had a portion of this good coal seam, has had now to resort to work coal in the Bensham and other lower seams of a much more inferior quality, which works tender, and these now, as well as other Collieries, enjoy no such decided advantage over its competitors as it did some time ago.

Among the several Ports on the Sea boundaries of the Coal district that of Newcastle is pre-eminent, as she has long been and must continue to be while the navigable waters which have so largely contributed to her prosperity shall lave her populated shores, and bear upon their bosom the products of her active industry to distant peoples and to foreign lands. The River Tyne is under the special guardianship of a Board of Commissioners, but was formerly under the jurisdiction of the Corporation of Newcastle, who, it may be remarked, although deriving a large revenue from it in various forms, were considered by many not very assiduous in

discharging the duties of conservancy which devolved upon them; or, perhaps, they might not have the ample means at their disposal to effect that for the Tyne, which the citizens of Glasgow, within the last thirty years, have accomplished, in only a few years after they began, for the Clyde. The duties of conservancy have been transferred to other hands, and it is to be hoped that those to whom it is now confided will avoid the censure which public opinion awarded to their predecessors.

The Tyne is capable of vast improvements, but this is not the place to indicate either the nature of them or the extent to which they should be carried out.

The present prosperity of the Tyne has arisen from sundry causes, involving mighty changes in the Coal Trade of the District, to which attention will be more particularly directed subsequently.

Before leaving the Tyne, however, there is one observation incidental to the general subject, which may be allowed. When Mr. Rowland Burdon built Sunderland Bridge he conferred an invaluable boon upon the inhabitants on both sides of the River Wear. With admirable foresight he effected arrangements, which, in a comparatively few years, discharged the cost of the erection, and the passage has since been thrown open, no toll being exacted. The venerable architect lived respected and died regretted in ripe old age, within a few weeks of the time when this magnificient work was confided to the public care. The Tyne Bridge at Newcastle, has been for some years exempt from toll, a privilege for which the inhabitants are indebted to the munificence of his Grace the late Duke of Northumberland, whose noble successor, the present Duke, reared and tutored as a British sailor, and inheriting all the excellent qualities that have rendered his ancestry renowned in war and foremost in the arts of peace, has established an especial claim to the gratitude and respect of all interested in the prosperity of the port, by his having exerted his influence and contributed largely from his princely means, towards the establishment of shipping docks on the Tyne at Hayhole, upon a scale of considerable magnitude. As another instance of his Grace's liberality towards the mineral trade of the district, from which he derives a great benefit, it may be stated that his support has been largely given toward the project of a railway up the North Tyne from the Newcastle and Carlisle Railway, from near Hexham, which will bring the manufactured Iron into this district.

There have been many projects before the public, from time to time, for the formation of Docks on the Tyne; but, notwithstanding the admitted necessity for such accommodation, and the professed willing-

ness of parties to meet the requirements of the case, these various projects were suffered to fall to the ground, and have been almost forgotten. The example set by his Grace the Duke of Northumberland and the gentlemen who are associated with him in the undertaking at Hayhole will be, it may be hoped, taken up and followed by other enterprising individuals at St. Peter's, below Bridge, and several other places above Newcastle Bridge, and if so, we may expect in a few years to have dock accommodation there, and at Jarrow on the north side of the Tyne, that may excel all other places in the world; also, for cheap Coal and Coke such as Warkworth, Amble, Seaton Sluice, and Blyth, that have grown up in reliance principally on such coal resources, as also the Middlesbro', Tees, Hartlepool, Seaham, and Sunderland Docks.

True, the basin of the Tyne is itself a capacious dock; but modern times have given birth to a system of centralization which is admirably organized and sustained in our docks and warehouses on the Thames, the Mersey, and the Humber.

Pursuing the eastern limit of the Coal Field, we arrive successively at Seaton Sluice a sort of dock or artificial harbour, which has been cut out of the solid rock at an enormous expense. Then further North we have Blyth next. Near to Warkworth, on the Coquet, is Amble Harbour, the trade of which consists chiefly in the shipment of Coal from one or two pits or collieries in the immediate neighbourhood, which hitherto have produced a sort of low priced Steam Coal.

There are many statistical details relative, not only to the trade of the different ports on the Northern Coast of England, comprised in the limits above described, and the facilities they afford for shipping, but that would lead into matters beyond the province of the present memoir.

At the same time it may be useful to give the Depth of Water on the Bars of the Rivers and Harbours on the North Eastern Coast, at which Coals are shipped in or during spring tides:—

	Feet.	Inches.
The Tyne	24	0
The Wear	18	6
Seaham	16	0
Hartlepool	19	0
The Tees at Middlesbro'	16	0
Redcar (Sea Coast)	43	0
Cowpen, or Seaton Sluice	15	0
Blyth	13	0
Coquet, Amble, Ratcliffe	13	0

CHAPTER IV.

STRATA OF THE COAL FIELD.

In a paper devoted to the coal field it only seems necessary briefly to notice the strata more immediately in connexion with it.

The coal measures throughout the whole of this district rest upon the mountain limestone and millstone grit, which crop out beyond the coal field westward and form the chief depository of lead ores, which are extensively worked at Allenheads, on the estates of W. W. Beaumont, Esq., M.P., and at Weardale, and other places on the edge of and sometimes within the coal measures.

The strata of the coal measures, or those which form the chief depository of this valuable mineral, are, of course, familiar to the members of this Institute, from sinkings which have been made through them. They consist of shales, grits, and clays, and the great abundance of impressions of plants found in them, particularly those of luxurious growth, such as the fern, &c., &c., indicate and sufficiently attest their vegetable origin.

Sections of the strata, from the highest to the lowest workable coal seam, in sinkings occurring at different parts of the coal field, will be subsequently given.

Immediately overlying the coal measures, where they lie at a great depth near the sea, is the lower red sandstone, which is very pure and unmixed with shale, and above this, over a considerable portion of the County of Durham we find the magnesian limestone, which in some parts is overlaid by the upper new red sandstone.

One remarkable effect produced by the dykes displacing the strata, upwards or downwards is the throwing in of patches of stratification in places where they would not be expected to make their appearance. Near to Whitley, where there is a small patch of limestone, the l red sandstone is found cropping out beneath it. At Killingwo consequence of the throw-down caused by the great Ninety-

Dyke, which runs from the Sea by Shire Moor through Killingworth, where it must be a very great downcast to the north, a patch of the same red sandstone is thrown in, being the only instance of the kind that is known in the County of Northumberland.

In the County of Durham, at Hesselton Dean, a similar case occurs with respect to the new red sandstone, which is thrown in with the displacement of strata by the Butterknowle Dyke, which throws the strata forty fathoms downwards. This is the only known instance that occurs of the new red sandstone being thrown in in that manner.

As the coal measures dip towards the sea in a south-easterly direction from the general line of outcrop, which varies in distance proceeding from the sea westward, it is in the latter direction that we may expect to find the several escarpments of overlying strata. If, on proceeding westward, we find the lowest workable coal seam, the Brockwell, at the surface, proceeding south-eastward towards the sea, the several members of the series of super-strata ought to make their appearance successively.

They undoubtedly do so with certain modifications arising from a variety of causes.

With respect to the coal series itself, when the seams lie at a great depth from the surface, they may be traced with considerable accuracy from one district to another. But on approaching the surface westward, these seams are found nearer to each other. Sometimes two unite and form one seam, or the occurrence of a slip may throw a seam out altogether, when all further trace of it is lost. The slip may occur in the opposite direction, and instead of throwing the seams out at the surface, throw them down perhaps several fathoms. Thus we find certain collieries, at no great distance from each other, differing very considerably in the number and quality of workable seams. From these and other circumstances, therefore, a section of the coal measures, say at Monkwearmouth Pit, will not find its counterpart on the surface at the coal measure escarpment westward. Some of the seams have run one into another, others have been nipped out or thrown out in the distance between the two places, particularly if that distance is very considerable. The debris of the surface, however, affords a certain indication of the strata below, and hence the line of the several escarpments can be accurately defined and delineated, as on the map produced.

The debris of lower red sandstone, intermixed with other strata of the coal measures, fills up the surfacial interval between the coal outcrop and that of the magnesian limestone, the existence of which, upon

the strata found beneath it, has given rise at various periods to much discussion and inquiry with respect to the character and quality of the coal sub-strata.

The escarpment of the magnesian limestone, as traced upon the map, runs in an irregular line. A small patch of it lies north of the main dyke at Whitley, in Northumberland, at Tynemouth Priory, and it strikes in again at South Shields after crossing the Tyne, and continues on across the Wear at Pensher Hill, Newbottle, Eppleton, Hetton, Moorsley, Elemore Hall, Pittington, Sherburn Hall, Coxhoe, Haswell, Shotton, Ferryhill, Cowdon, Thickley, and Middridge, into Cleveland in Yorkshire.

The out-crop of lower red sandstone is shown with a thin intermediate stratum of shale in some places immediately beneath it, particularly where it is deep. The sandstone appears on the surface in many places as fine soft sand. As this sand, or lower red sandstone, dips under the limestone it becomes more compact, and at a great depth is found hard with gullets or cracks in it filled with water, which comes off into the shaft, when sinking, in enormous quantities, bringing with it particles of sharp sand, so that the leather buckets used for pumping (a practice I would not adopt, as those buckets, which must be worked with great rapidity and power to overcome the influx, are made of leather,) do not last many hours when the water is at a heavy pressure, in consequence of its great depth. It may be remarked that in one case, that at South Hetton Dalton Colliery, the cost of the leather for the buckets, was at the rate of £100 per week for a year or two, while little or no progress whatever was made in sinking until they got through the bed of sand, which difficult part was only a few feet in thickness. A similar occurrence took place in the first pit sunk at Haswell, where the sand was softer and much thicker than at South Hetton Dalton Pit, which is further to the dip, and the proprietors were obliged to abandon it in consequence before they got through the sand, after spending upwards of £60,000. They afterwards sunk a short distance westward, to the rise, where they had to sink through the same strata, and to their agreeable surprise, the sand being nipped out, there was little or no water found.

With respect to the magnesian limestone in the County of Durham, and the differences of opinion prevailing with regard to the quality and character of the coal sub-stratification, a few remarks here may not be out of place.

The author of a popular work entitled "Our Coal and Coal Pits," extols the sagacity of Dr. Wm. Smith, the Father, as he may be termed, of English Geology, and inferentially depreciates that of some of the

late colliery viewers on the Tyne, who, it is reported, entertained an opinion regarding the quality of the coal underlying the limestone formation in the County of Durham, and the expense of working it, which was unsupported by theory and not justified by experience.

Now, so far from this being the case, it turns out that experience is in full accordance with what was predicated by the late Mr. John Buddle, and the viewers referred to, so far as experience has gone and new facts have been elicited. A very great portion of the coal under the limestone has not yet been proved. That which has been proved has not been of sufficient extent, or found to be of sufficient thickness and good quality of coal to warrant any one in making any positive contradiction. The Hutton seam under Moorsley estate was worked a short distance under the limestone and found to be good, as was known to the late Mr. Buddle, as well as myself, at the time he is said to have made the remark that his opinion did not go so far as to lead him to believe that any great extent of the good Hutton seam would be found under the magnesian limestone.

Since then, the experience of thirty years has thrown additional light upon the subject, and I hold that his opinion was consistent with truth, and it has been confirmed to a considerable extent.

A great portion of the coal under the limestone, as already stated, has not yet been proved, particularly where the limestone is overlapped by the new red sandstone. In that portion which has been proved, the Hutton seam, which is considered the most valuable coal, is of unequal thickness. A great portion of it is so thin that it is unworkable to profit; and, where this thinness occurs there is only one seam above it that can be considered workable of good quality, namely the Five-quarter, which is only a thin seam compared with the good Hutton seam, and although of good hard quality, where of sufficient thickness to be workable, in many districts it is not in all, and in some cases where it is in it is so thin or so bad in quality, as at Croxdale, Whitwell, Byers-green, &c., as not to be workable. Therefore, even the Five-quarter cannot be taken into account as a regular workable seam throughout the proved coal district under the limestone. When the Hutton seam is thin, and the Five-quarter above it is not workable, recourse has been had, in some cases, to the seams below, which require deep sinkings, and when reached are also found to be comparatively thin and tender, the coal being suitable for coking and gas, and does not bring the price of the best Hutton seam and Five-quarter or Main Coal at Tees Wallsend by one-third.

The remaining portion of the Hutton seam under the limestone, which may be considered good, lies south of the Hett Dyke from Easington to Seaham, next the Sea, and from Seaham or Ryhope, or a little north of it, to Pensher, on the Wear, and thence to Durham, and by way of Shincliffe and Sherburn to the Hett Dyke, near Thornley.

The area thus circumscribed, it will be seen by reference to the map, is only of very small extent, and little more than one-half of it, namely that portion next the sea, is overlaid by limestone.

In that portion under the limestone where the Hutton seam has been proved to be in good perfection, a few deep pits have been sunk down to it through the limestone, and a great many other pits have been sunk on the borders of the limestone, working underneath it as well as to the rise in the opposite direction, and these pits have already worked a large portion of good coal from under the limestone, and those with others working to the rise, have worked out nearly the whole of the Hutton seam up towards Durham.

Therefore, the pits on the border of the limestone already referred to, and others sunk to the rise in that portion of the good Hutton seam district which is not under the limestone, have exhausted, or will very shortly exhaust, the whole of the workable seams that can be got in that division, and which are known as the Five-quarter, Main Coal, Low Main, and Hutton.

The seams below the Hutton in this district are yet unexplored. At Haswell, the Beaumont or Harvey, the next workable seam to the Hutton, has been bored to at the customary depth. As to the seams below the Beaumont, their thickness has not been ascertained. Even the number of workable seams below the Hutton in this district is doubtful. Indeed it is questionable whether there be more than two; for, although in the Tyne there are four workable seams proved below the Hutton, averaging upwards of a yard in thickness, these lie from ten to twenty miles beyond the out-crop of limestone at Tynemouth, whereas, at Blackboy, in the Tees Auckland district, where the limestone runs off, about twenty miles from the Sea at Hartlepool, there is no proof that there are four workable seams below the Hutton, and it is doubtful whether there are more than two there, and although they lie at a great depth, they rise out to the surface within one mile southward, and a few miles westward, by way of West Auckland and Etherley, as may be seen upon the map.

Upon the whole, that portion of the coal field, in Durham and Northmberland, which is covered by the magnesian limestone, amounts

only to about one-sixth of the entire area, and in only one-half of that can the Hutton seam be considered good; in the other half it is not workable to profit. The same observation applies to several of the other seams, particularly the Main Coal and Low Main, which have been sunk to in various places.

Having disposed of the collateral question of coal under the limestone, it only remains to state that the new red sandstone overlaps the magnesian limestone from North Hartlepool to near Middridge, where the Tees Wallsend seams crop out.

Its northernmost point is at the Hett Dyke, between Hutton Henry and Wingate Grange Colliery. Southward it continues thickening to the Tees till it is overlapped towards Redcar by the alum shale.

A little to the south-west of Redcar are situated the now extensively worked iron ore districts of Cleveland.

CHAPTER V.

COLLIERY DISTRICTS AND COAL SEAMS.

The Tyne district was formerly the most important in the Coal Trade, both as regarded the value of its coal seams and the number of its collieries in operation, but it is at present excelled in finer, harder, and better qualities by the Wear and a portion of Bishop Auckland, called the Tees Wallsend district. Nevertheless, it still retains the first position upon the official lists, published by the Committee of the Coal Trade, as it still comprises the largest number of collieries. There appear in the circulars issued by the Coal Trade Committee, at the present time, the names of 134 collieries, and most of them have several different pits or working shafts. There are 64 collieries in the Tyne district, 24 of which are distinguished for producing good household coal, the like number (24) a coal suitable for coking or the manufacture of gas, 6 collieries producing coal suitable for steam purposes, and the remainder an article of a promiscuous character between household and coking coal.

These characteristic differences in the quality of coal shall be afterwards investigated and explained, as they have an important bearing on the consideration of the general subject of the Coal Trade and the probable duration of the coal field.

Four collieries, all supplying steam coal, are enumerated in the Blyth district, but they ship coals also on the Tyne. Three extensive collieries, supplying household coal, belong to the Seaham district. On the Wear there are sixteen collieries, all of which, excepting one, produce household coal. And in the Tees district there are twenty-one collieries, ten of which yield household coal.

The information, with respect to the various collieries in the coal district, set forth on the subjoined table, has been collected with great care, and as a statistical record of the present state of the trade in this part of the kingdom will be regarded with interest and importance. *(See Appendix.)*

It has been calculated there are about fifty-seven different seams of coal in the Newcastle Coal Field, varying in thickness from one inch to 5 feet 5 inches, forming an aggregate of 75 feet 7¾ inches, but some of them are so thin that they cannot be worked so as to be remunerative, on which account their existence is of little consequence. Judging from past experience and present prospects generally, a seam, to defray the expense of working and leave a return for interest of capital and risk, ought not to be less than from thirty inches to near three feet in thickness.

Seams of coal have been in some cases wholly excavated, or so much has been removed as could be done with safety. Formerly much more coal was left in the seams as irrecoverable than in the present day, as we have now a much more efficient plan of working than was in existence during many hundreds of years. In such cases the mine has been either lost or abandoned, or recourse has been had to other seams in the same mine of inferior quality which are worked at greater expense than the others, while the produce of them will not bring so high a price in the market. The profits, if any, in such cases, must be extremely precarious and uncertain. The following is a list of what may be termed workable seams in the Northern Coal Field, according to the designation they receive in the Wear district:—High Main, Five-quarter, Main Coal, Bensham, Hutton, Beaumont, Stone Coal, Low Five-quarter, Three-quarter Seam, and Brockwell.

These several seams vary in quality as well as thickness, and some of them are known by different names in different districts; thus the Bensham Seam of the Tyne is known as the Maudlin Seam of the Wear; the Beaumont or Harvey Seam is known in Townley Colliery as the Townley Seam; and in Wylam Colliery, as the Main Coal Seam; and so of others. Even some parts differ in quality from others in the same seam, so that great diversity exists in that respect throughout the entire district of the Northern Coal Measures.

The High Main Seam of the Cramlington district separates into two at Hetton, and is there called the Three-quarter Seam; unites at Pontop under the name of Shieldrow Seam, and again at Auckland takes the name of the Three-quarter. The Grey Seam of the Cramlington district forms the Metal Coal Seam, and the Stone Coal Seam at Sheriff Hill, uniting to form the Five-quarter Seam at Hetton, running close to the Brass Thill Seam at Pontop, still preserving its name, and rising in the strata in the same name in the Auckland district. The Yard Coal Seam of the Cramlington district retains the same name at Sheriff Hill, becomes the Main Coal Seam at Pittington, Hetton, Haswell, and Houghton-le-Spring,

the Brass Thill at Pontop, and the Main Coal at Blackboy in the Auckland district.

The Bensham Seam of the Cramlington district, is known as the Maudlin at Sheriff Hill, as the Low Main at Hetton, and runs into the Hutton Seam at Pontop; and is marked by Mr. Greenwell in the Blackboy Colliery as Surtees' Seam, at a very deep boring at Blackboy Old Pit. But this seam wants identification. There appears to be less doubt, by mining engineers, as to the present Five-quarter and Main Coal Seams being the same seams as are so-called in the Wear district, which district, namely, Tees Wallsend, will be seen on the map only of small extent. These seams are now worked not only at Blackboy and Tees Wallsend, but at Coundon, Leasingthorne, Eldon, and Adelaide Collieries, and yield a superior quality to any other Five-quarter or Main Coal, or in fact the Hutton Seam, besides there is great thickness of good coal of proper hardness.

The Five-quarter Seam of the Cramlington district divides and forms the Six-quarter, and the Five-quarter at Sheriff Hill, the Brass Thill Seam at Pittington, which unite there, and run together into the Hutton Seam at Pontop Colliery. The Low Main Seam of the Cramlington district retains the same name at Sheriff Hill, becomes the Hutton Seam at Hetton, and the Main Coal at Pontop, dividing into two thin seams in the Auckland district.

In Townley Colliery, in the Ryton district, the coal is worked in the Beaumont, which is the Harvey or Townley Seam, the Stone Coal, Five-quarter, and the Brockwell Seams. The Tilly and the Hand Seams, between the Beaumont and the Stone Coal, and the Three-quarter, between the Five-quarter and the Brockwell, are not of workable thickness. This is all coke and gas coal. The Stone Coal and the Five-quarter Seams run together in patches at Townley Colliery and other places, and they form the Busty Bank Seam of the Pontop district.

The Three-quarter Seam of the Sheriff Hill district is twenty fathoms above the High Main Seam.

CHAPTER VI.

THE DIFFERENT KINDS OF COAL.

The seams of Coal not only vary in thickness, but they also differ in quality, and even the same seam alters in different and often in the same district. Sometimes a seam is nipped out and disappears from the series. In other places, it runs into and it may be said becomes part of other seams. In consequence of the gradual rise of the seams to the westward, and the uneven surface of the ground, particularly when undulated as in the valleys of rivulets and streams in the western districts, which valleys are still above the level of the sea, and the hills on each side of the Derwent and Tyne from 500 to 1,000 feet above it, one seam may come out much sooner than the other, the lower one at all times continuing further under the surface. In all the districts the whole of the seams of coal appear except near the western outcrop, that is to say, they are all found either in a good or bad condition, but at the western outcrop the Beaumont or Harvey, the Five-quarter, Stone Coal, and Brockwell often run together and form only two seams before they appear at the outcrop. In the Blackboy district further east, as already remarked, it is questionable whether there are any more than two workable seams below the two seams that are at present being worked, and which, continuing westward, come into one at the outcrop. The sloping banks to the west of the coal district, and the rise of the coal in the same direction in many cases, cut the higher seams out a mile or two before the lower seams reach the surface, or cause them to become so much altered that they lose their distinctive characters, and it is difficult, if not impossible, to determine which seam the really are, and whether they possess any value or not.

Of course, the lower seams will continue longer under the surface westward than the upper ones, consequently, these upper seams cannot be measured as over the whole surface.

Those that have read Mr. Greenwell's work upon the Western District will find that he makes allusion to this. The doubt which arises

is, which name is right—whether the seam ought to be called by one name or the other.

This is particularly observable on approaching the escarpment of the coal field, where very few, and in many cases not more than a single seam appears. In the outcrop, two and sometimes three seams run together, but this arises from local circumstances, and does not afford any criterion by which to judge of the whole of the different coal seams, which vary in thickness, but correspond in number one with another, when properly traced through the various coal districts, except where good reasons can be given for their non-conformity. Sometimes the direction of a seam is suddenly altered; it is thrown upwards or downwards by hitches or slips of the strata. In the proved districts of the coal field, these various circumstances and conditions are ascertained and recorded; and, from the information collected, the state of other districts where the coal has not been proved may be inferred. This is particularly observable on the map produced.

Household Coal.—The best quality of coal is considered to be that which has been found most suitable for household purposes, and termed on that account household coal. It has hitherto brought the highest price in the market, and is in universal demand. As regards price, it may only now be said to be excelled by a very limited portion of a certain seam below the Townley seam at Blaydon and Stella, which is in high repute, and selling at high prices for gas purposes only. Indeed, it is only within the last half century, that the seams which are now generally considered to yield the best household coal were opened out for working. Before this period there were certainly Wallsend, Heaton, Percy Main, and some other collieries on the Tyne that were working good Coals which have since been nearly worked off; but, even if that were not so, and these coals had been in the market, they would not have brought the price of what are now regarded as the best coal by 4s. or 5s. per chaldron. There was at that period a fine tender coal of good quality worked, which augmented the supply of household coals; at that time the household customers not being so particular either as to size or quality. This Coal, at that day, was very much used for smithies, and also for the manufacture of gas, iron, refining of sugar, and also for the quantity of coke that was required. This is now worked extensively for coking and gas as well as the other manufacturing purposes to which it was formerly applied, the demand having increased a hundredfold, and being likely to continue while cheap iron ore can be got.

Household coal is described generally as bright and cubical; it preserves its form in regular blocks after the small is taken from it. As an instance of this, it may be stated that one block was hewn at Blackboy Colliery, for the purpose of being sent to the Middlesbro' drops on the day of opening them, in 1831, and from thence to the Coal Exchange in London, weighing no less than 3½ tons. This was the largest block ever received by shipment from the Northern Coal Field. This coal burns to a black cinder, which in turn is consumed, so that only a small portion of ashes remain. Its freedom from sulphuret of iron render it admirably adapted for the purpose to which it is applied.

The best coals for household purposes, after being drawn to the pit mouth, are passed into waggons, in most cases, over a five-eight of an inch screen, and the "duff" is that which falls through another screen, the latter leaving, of course, nothing but very small; only a very small portion of this coal is turned to refuse at the present time, for the dirt is sifted out of the duff; in some cases it is washed out by a machine invented for the purpose. The best portions of the duff are used for manufacturing purposes, in places where there is a demand for it. This was not the case formerly, for nuts and duff were thrown aside and accumulated near the pit mouth, where storage ground was required to be provided. Hundreds of thousands of tons of these coals were annually destroyed as waste by burning.

This was, in fact, at that time the most economical mode the proprietors had of disposing of them, for they could not be sold at a price to cover rent and leading expenses, without the working charges, which were very considerable, so that all the weight came upon the large, and, besides, for many years there was a heavy duty chargeable on sea-borne coal, which of course tended to limit inferior sorts and to enhance the cost to the consumer. The abolition of the duty, and the repeal of other imports which crippled the coal trade, have been followed by an increased demand for coal of all descriptions, and the high mountains of black diamonds which once disfigured the surface of our fields and invited the comments of strangers and travellers have nearly disappeared. Nothing more clearly shews the policy of taking off a duty than the remission of the import of sea-borne coal, which, as in the case of glass, has led to a greatly increased consumption and its application to uses to which it was formerly unapplied.

The screening process, to which we have referred, was not resorted to with respect to coal used for coking or gas, iron factories, sugar refineries or smithies, as the small in some districts was found to answer the

purpose quite as well as the other on account of its fine bituminous nature. The steam coal was, however, screened, until lately, the practice having been abandoned since the increased demand arose, and the low prices at which these coals have been sold at the shipping places on the river Tyne.

Steam coal is distinguished by the rapidity with which it generates heat.

Its combustible elements readily unite and burn with great intensity, leaving a white ash, which, after a time, disappears through the fire bars or the draft of the chimney. Instead of the dark cinders and bright clear fire produced by the best household coals, there is a large portion of dust and dirt which are by no means agreeable accessories to the parlour or drawing-room.

This coal is principally used for the purpose of heating engines and steam boilers, especially those of sea-going vessels. Its specific gravity is 1·26, a cubic yard of it weighs a ton.

Steam coal is now found in seams of considerable thickness, nearly from 6 to 7 feet, of a different appearance from what is called splint or cannel in this district. It looks like the best household coal, but it burns like splint to a white ash. These three kinds are suitable for steam purposes but more particularly that obtained from the thick seams, north of Blyth, Cramlington, and others, as the splint and cannel coals are only found to be a portion of the seams in their beds; the thick seams can be worked to more advantage and in a larger quantity than the thin ones to meet the demand.

Coking Coal is characterized by the large quantity of carbon which enters into its composition, amounting in a general way, in that obtained from Townley, Marley Hill, Garesfield, and Bowden Close, Pease's West Pits, Hunwick, Byers-green, and Brancepeth Collieries, to 80 per cent., 19 of the remainder consisting of gaseous matter, and only 1 residium or ashes, making the best coke. The residium may be even diminished by an improved oven, properly ventilated and managed, for which I am about taking a patent. It is more tender and finer than household coal, and rapidly crumbles or falls to pieces, and becomes dusty. It is laminated in structure, and open in what is called the facings or the fibres. It cakes or runs into a plastic mass on the application of heat, and yields a reddish white ash when burned. Coke may be considered as the fixed carbon of the coal.

It is manufactured upon an extensive scale in many parts of the western portion of the County of Durham, also on the Wear, and on the

Tyne, in ovens built expressly for the purpose, either in the vicinity of the mines which yield coal of quality suitable for the purpose, or in localities where facilities exist for bringing the coal to it at a cheap rate, and disposing of the manufactured article to advantage.

There is a very marked distinction between cinders and coke, which is of course, familiar to those in the trade. Coke if good, sinks in water, bad coke and cinders swim. The reason of this, observes Dr. Ure in his "Dictionary of Arts," is "The longer and higher the heat to which carbon from wood or coal is exposed, the more it contracts, and consequently the denser it becomes. The volatile combustible matter of the coal is employed in producing the requisite temperature for coking, and the oven is or ought to be so contrived, as to retain the heat and a proper quantity of air a sufficient time to produce the necessary aggregation of the particles of the carbon, or in plain words, the condensation of the coke which is discharged out of the oven in one mass."

The specific gravity of good coke is about ; and its weight per cubic yard of about .

Splint coal is heavier in specific gravity than other coal. It is sometimes found very pure at the top of the Townley, Beaumont or Harvey seam, which are all the same seam, but which are called the main coal at Wylam, and Engine Main at Walbottle. At Townley this top splint coal is very good, and it is also found very good at the bottom of the Brockwell seam in those three last-named collieries, seldom running thicker than eight inches. It is equal in quality to the rest of the seams in which good splint cannel coal is found, but is generally worked in this seam along with the other portion, and is advantageously mixed with it in the process of manufacture of coke or gas, where there is always a great demand for it.

The Townley splint coal is extremely brittle, burns away like wax, and leaves a considerable quantity of white, powdery ashes. The Brockwell seam splint in the western collieries on the Tyne works more in blocks like cannel coal, and is also much in demand.

Cannel Coal, when found in entire beds, as in Lancashire, is not of so brittle a nature as what is called splint, and worked more in blocks. It can be turned in the lathe, and will receive a high polish. The cannel coal is found under and forms the lower part of the Brockwell seam, the lowest of the workable coal seams; it varies in thickness from five to ten inches. When this coal seam lies deep on Tyneside, it is often thinner and more tender in its nature than what it is when it comes nearer to the surface. At Wylam, Townley, Eltringham, Bywell, and Mickley, this coal is found in a good state. It is used for the same purpose as splint

coal. It is very bituminous, and in making coke or gas it is mixed with the smallest of the best coal, which causes it to burn much quicker than it would do alone. The admixture is also beneficial in another respect, greatly accelerating and improving the process of manufacture. Occasionally in other coal districts the splint and cannel coals are found in distinct beds in very small limited districts, where it is generally of a much harder nature, as at Blaydon and Stella, and part of Grand Lease, where it is of another quality of coal, which is now being brought into operation, but which had not before been noticed as a workable seam in that district. It lies between the Townley and the stone coal. It is very thin and only worked of suitable quantity in small patches on the south side of the main dyke at Blaydon and Stella. It brings a good price in the market for gas purposes, being nearly equal in quality to the best gas coal in Scotland. On account of the thinness of the seam, viz., from two feet to two feet three inches, with a band in it, it is expensive to work, consequently where it is worked it has to be sold at a high price, and besides, there is only a very small quantity of it in this district. This seam, in a great extent of the district, is not of that same good quality, and consequently is not or never may be workable to a profit. The seam is so small that particular kind of workmen would have to be increased so as to obtain a greater quantity, as this seam is not like the Scotch or Lancashire thick seams.

The coking coal seams, where they are tender, are very apt to have what are called partings, fibres, or facings, often at an inch or inch and a half asunder. When these seams lie near the surface, these partings sometimes admit of a dampth of water, and after having been stagnant and drained off by working the coal from the dip towards the rise or surface, the facing, when broken up dry, presents a very beautiful appearance, being traced with lines resembling the colour of the feathers in a peacock's tail.

CHAPTER VII.

COAL FORMATION IN THE TYNE DISTRICT.

Under this head it is proposed to give a description of the various seams in the different districts of the coal field, with sections when necessary.

In the first place, we shall describe the general character of the seams of coal in the Tyne District above Newcastle Bridge.

The Seven Feet High Main Coal, No. 1.

This main coal seam, the highest workable seam in the series, is found close to the north side of the Ninety-fathom Dyke, at a depth of from two to thirty-five fathoms beneath the surface. This seam gets thicker when at a great depth near the trouble, as do all the other seams below it next the vicinity of the trouble.

It is not of large extent as it rises quickly to the outcrop.

It is generally from seven to eight feet in thickness, and yields a compact coal, in good sized blocks. It burns to a brownish white ash. From the specimens I have seen I am of opinion that it would have answered well for similar purposes, and might have worked much in the same way as the Cramlington, Hartley, Seghill, and Seaton Delaval steam coal of the present day. This was a very valuable seam in former times, having been in great demand as a household coal, but it has been so easily got as to be entirely worked out, or is now only found in very small pillars or patches, and even these are unworkable. It lay above the level of the Tyne and was easily and inexpensively drained into that river.

Craw Coal, No. 2; Old Five-quarter, No. 3; Cannel Coal, No. 4.

These seams generally run together, or with very little stratification between them, in consequence of which they were worked separately and sometimes in conjunction as in former times. The Craw Coal is on the

average about three feet, and the Five-quarter about 3 feet 6 inches in thickness; and there is in some places another seam of coal like Cannel Coal about 2 feet 3 inches thick near the vicinity of Greenside, in Ryton parish, next the root of the main dyke, with a portion of stone strata between each of those two former coal seams, which have been partially worked. The Cannel Coal not having been worked at all in that day, in consequence of a white ash coal not being saleable.

The Crow Coal and Five-quarter seams yield tender coals, which are easy to work, but in quality are not so good as the lower seams, since the opening out of which they have been generally abandoned; but, not, however, until they had been extensively worked. In many situations west of Newcastle, these seams are also above the level of the Tyne and were all drained into it by day levels, made centuries ago.

These day levels are at present used as delivery drifts for the water made on or about the same, and for pumping water from the lower seams, as at Townley, Stargate, and C Pits, near the Main Dyke, and "Kitty's Drift," commenced in the neighbourhood of Bell's Close at the surface, but when Kitty's Drift was under Denton and Kenton, being then thirty, forty, or fifty fathoms below the surface, they found, to their disappointment, that the seams they were aiming at were considerably below the level of the drift, and they then economised the lifting power of the pumping engines in making use of this drift. The Crow Coal and Old Five-quarter, are not so easily kept clean of pyrites as the lower Five-quarter.

The Ruler, No. 5.

This is a seam of excellent quality, but in this district being only about 2 feet 6 inches in thickness, it has not been worked except to a small extent in Townley Colliery, but, may be worked more extensively after mechanical power has been adapted to the hewing of coal.

The Ruler would appear to be the Hutton seam of the Wear district, the good quality of which it very much resembles, besides lying at the same distance immediately above the Townley or Beaumont seam, which is the first of the series of coking coal, and equally good in quality.

Townley, Harvey, or Beaumont, No. 6.

This seam averages from 3 feet 6 inches to 4 feet 8 inches in thickness.

About ten inches of the top is fine Splint Coal, and the remainder a good coal for household purposes, also for coke and gas, but has a small band under the Splint. The best part of the Townley seam is harder than the three or four seams below, which are also of good quality, with a small band occasionally occurring near the bottom, but which increases in certain districts. The quality of the Townley is excellent, but not so hard, although much more durable than the Ruler above it, which is the Wear Hutton Seam.

This coal is of very fine bituminous nature, free from pyrites, and suitable for the manufacture of coke and gas, in which it is extensively used. It is probable, however, that for these purposes, it is excelled by the lower five workable coal seams, Nos. 7, 8, 9, 10, and 11, namely, the thin Splint or Cannel Seam, next below the Townley, at Blaydon and Stella, and the Stone Coal, the No. 9 Five-quarter, with the No. 10 Brockwell seams for coke and gas.

Gas Coal Seam, No. 7.—This is an excellent seam for gas, particularly on the south side of the Main Dyke, where it is found good in patches.

The Stone Coal, No. 8.—This seam is from 2 feet 10 inches to 3 feet 2 inches in thickness. It is uniform in quality, and is suitable for gas purposes, and most particularly for coke.

Five-quarter, No. 9.—The coal for about five or six inches at the top of this seam yields a white ash when burnt, but it is not of a splinty appearance. The remainder, about three feet in thickness, resembles the Stone Coal, and is used for similar purposes, for which it is well adapted.

Three-quarter, No. 10.—Is a very hard, coarse coal, and has been very little worked on that account. At Wylam it is a very good seam, and is worked in perfection there with advantage, and well known by the name of the Yard Coal.

The Brockwell, No. 11.—This is the lowest workable seam that has been sunk to in the coal formation, which has only been done at a few places, namely, Townley, Stella, Blaydon Main, and Norwood Collieries on the Tyne, but it has been bored to at the Blackboy, in the Auckland district, and also at West Auckland and Etherly, where it is known sometimes, when two seams run together, as the Main coal.

The average thickness of the Brockwell seam in general is about 3 feet 6 inches. About 6 inches of that at the bottom is Splint, which burns to a white ash, the remainder is of excellent quality for coke

and gas purposes. In some places there are between two and three inches of Jet at the top which looks like stone or slate, yet it is used for the workmen's fires at Wylam.

It is questionable whether the Auckland and Etherly seam is the Brockwell or the Dusty Bank.

The Stone coal and Five-quarter coming together form the Dusty Bank at Pontop, but go by other names elsewhere. The Stone Coal and Five-quarter are closely connected throughout the district.

The seams below Newcastle Bridge, both north and south of the main dyke, differ in hardness and quality from those to the west of it.

CHAPTER VIII.

DISTRICTS DISTINGUISHED BY THE NATURE OF THE COAL THEY CHIEFLY PRODUCE.

HOUSEHOLD COAL DISTRICT.

By generalizing the differences in the quality and character of coal, described in the preceding chapter, we are enabled to introduce a sub-division of districts, based thereupon, which will be found convenient and important in a consideration of the coal trade. This sub-division will comprise:—

I.—Collieries producing *Household* coal. These are situated principally in the south eastern district of the coal field from Haswell, Hettons, Houghton, to Port Seaham.

II.—Collieries producing *Coking* coal. The best of which are found in the western district, from the river Tyne, above Newcastle, to the river Wear, near Brancepeth.

III.—Collieries producing coal of a quality suitable for *Steam* purposes. The principal of these are situated in the north-eastern division of the coal field, along the sea coast from Blyth to Widdrington Castle.

IV.—The fourth division includes all those collieries that are not embraced in the other three divisions, places that have not been proved but where the coal was doubtful or supposed not to be workable hitherto at a remunerative price, or that have been proved and abandoned, or the workings are being carried on in many places with little profit.

This division is not limited to any particular locality, but lies scattered in considerable patches over the entire coal field. Some of the districts or collieries have been worked off in the best seams of coal in former times with profit.

The annexed Nos. 1 and 2 plans have been prepared in order to elucidate this part of the subject. That portion of them which are coloured *black* represents the locality of the best household coal; *blue*, coking coal; that which is *brown*, steam coal; while the several parts of the fourth division are *tinted with a cloudy, smoky appearance.*

It is not affirmed that the whole of the coal found in those localities thus specially indicated is used exclusively for the respective purposes which has furnished the characteristic terms applied to each division, but that these distinctive features of the Northern Coal Field are so prominently marked that we are justified in adopting them as the basis of an arrangement upon which to found our observations.

The best household district lies south of the Wear, and a patch of it, about a mile or two in width, runs along the Ninety-fathom Dyke, and lies at a great inclination towards and up to this dyke from near the sea till it joins the coking district, after crossing the Tyne at Stella, between Blaydon and Newburn.

The coking coal occupies nearly the whole of the western district, and the steam coal is found in the greatest perfection a little northward of the Ninety-fathom Dyke, beyond the limit of the household coal district. It may be desirable to consider each district separately.

HOUSEHOLD DISTRICT.

The best household coal, as already stated, is worked principally in the County of Durham, south of the river Wear. A line from Seaham Harbour, by Easington, Shotton, Thornley, Ludworth, Shincliffe, Cassop, Lord Londonderry's Pit at Elvet, near Old Durham, and thence by the river Wear to Pensher, and then on to the sea south of the entrance of the Wear, will circumscribe the principal portion of the household district. There is a small portion on the west side of the Wear, at Auburn House and Waldridge Fell, near Pelton, where it joins the coking coal district. Household coal is worked in the Main and Hutton Seams, and it is somewhat remarkable that wherever the Hutton Seam and the Main and Low Main Seams are found to be good the upper Five-quarter is almost invariably inferior (Pittington being, I believe, the only exception), and often it is not in the coal series at all, as at Moorsley, North Hetton, South Hetton, Elemore, and Lord Durham's Houghton Pit, and many other places.

On the contrary, where the upper Five-quarter seam is good in the Wear or Hartlepool districts south of the Hett Dyke, the Hutton Low Main and Main coal seams are in most cases thin, and unmarketable with profit, and whenever the upper Five-quarter and upper Main coal seams are good between the Wear and the Tees the lower Five-quarter, the lower Main, and the Hutton seams are not good, as for instance at Blackboy, "Tees Wallsend," Eldon, Adelaide, Coundon,

Leasingthorne, and part towards Ferry Hill. The upper Five-quarter and Main seams in the collieries just named are of a quality which is suitable for the best household coal.

The lower Five-quarter, which is found at Trimdon, Wingate, Thornley, Cassop, Coxhoe, Bowburn, Crow Trees, Pittington, and some other collieries, yield also good household coal; at Byers-green, Whitworth, and Old Park, not so good where the coking district puts in. At a few places in the same neighbourhood, not included in the part shaded black on Nos. 1 and 2 plans, the coal marketable as household is worked in the Five-quarter seam so called, and those parts of it lying between the Butterknowle and the Hett Dyke yielding household coal before they were abandoned. Again, where the Hutton seam is turning inferior, from the Londonderry Pit at Pensher, where the Hutton seam is only thin, and towards the sea, a distance of about six miles, the seams of coal, although thicker, are tender, as is proved where worked to the south side of the Wear from Monkwearmouth Pit, towards Tunstall, and Ryhope, and Seaton, and are at so great a depth along the sea coast towards Seaham, and much more tender both near the sea and approaching the Hett Dyke, as to prevent their being won and worked except at comparatively great expense and risk, for when the Hutton seam is tender it brings a much less price. The limestone there being so very thick, as is proved at Seaton, Dalton, and Monkwearmouth pits, there is at present less necessity to incur that expense, since the same quality of coal may be obtained by sinking farther inland, where the seams lie near the surface and may be worked to the dip underground by means of steam power. Yet in the estimate of our Coal Field I have, in two places, calculated for about nine miles in width, one opposite the best Hutton Seam coal district, the other under that portion of the best Steam Coal district, next the sea coast at each place, as there may be a possibility of some parties attempting to work coal under the sea at those points. I have, therefore, in my estimate, allowed such enterprising persons an extent of coal that may dip, and get to a great depth under the sea at the distance of two miles, which I have taken into account. The writer considers that there is abundance of risk and plenty of room in going half a mile under the sea to deter the more cautious speculators from doing so, until the good coal elsewhere is worked off. An allusion to this matter will be made hereafter. The best Hutton seam where sunk to below the Main coal is generally free from water, and consequently requires little or no drawing. The Hutton seam also extends west-

ward to near Whitwell and Croxdale, where it becomes so very inferior and thin as to be unprofitable to work, and so it continues till it joins next above the coking coal districts of Brancepeth and Brandon, Willington, Byers-green, Bowden Close, and over the Derwent to Townley on the Tyne, where it is found thin but hard, good quality. The best description of household coal was formerly wrought on the banks of the Tyne, in the High Main Seam at Wallsend, where the quality was good, and it brought a higher price in the market than any obtained at that time at other places in the same neighbourhood. Its reputation continued as long as the coal lasted in the pit, as well as several others from the same seam, which obtained the same name.

In consequence of the repute the seam had obtained, many parties applied the name to very inferior coal seams, sunk in the same district, and even continued to do so for a very long period in new districts, but time and trial proved that the name alone would not do when the quality was wanting, consequently when the late Mr. Buddle found that the Wear districts were full of good coal, principally the produce of the Five-quarter and main seams which were then being worked under the name of Ducks and Eden Main and suited the London market well, he very properly gave the name of Wallsend to and began to bring the Hutton seam into the market, calling it by the name of Stewart's Wallsend. That established the name of Wallsend as a general designation for coal so excellent as this was. The coal south of the Wear shortly before that was unexplored and but little known, only having been wrought by the Tempest family, the Lambtons, and Neshams, and the opinion generally entertained by the mining engineers of that day was that no good coal existed to any extent under the magnesian limestone, but that it was of very inferior quality and thinner.

The opening out of the Wear district took place almost simultaneously with the exhaustion of the best seams on the Tyne. The pits were first sunk westward of the outcrops of the limestone and were worked in the Main and Five-quarter seams, but soon afterwards when Mr. Buddle succeeded Mr. Arthur Mowbray, as manager for the late Marquis of Londonderry, then Lord Stewart, it was soon found that at Lyon's the Hutton seam was good under the outcrop of the limestone, it having been approached from Moorsley. Lyon's Hetton and the North Hetton company also sprung up, and at Moorsley followed the example set by Mr. Mowbray in sinking and working the Hutton seam, and their example was followed at South Hetton, Dalton, Seaton, Haswell, and other places at greater depth, where the Hutton seam under the edge of the limestone was found to exist in great perfection, and that, years after, led to sinkings through the limestone at Monkwearmouth, Dalton, Seaton, and other places.

As the best seams of coal on the Tyne became exhausted or nearly so, inferior seams, worked at greater expense and less valuable, were resorted to, the produce of which was brought to market, sold for one-half the price the best coal formerly did, while the best coals were worked at a cheaper rate.

But to take a much later period let us go back to about a little more than ten years ago when prices were nearly double what they have been up to July 1853. The Hutton seam in the household district along with the Main Coal and Five-quarter seam, were worked to considerable profit, but during the last ten years it is very doubtful whether much profit has been derived, if so, very limited, from the sale of coal worked out of the seams above mentioned, and which have been more extensively worked by Lord Londonderry, the Earl of Durham, the Lyon's Hetton, the Haswell, North and South Hetton, Belmont and Thornley, the Seaton, Seaham, and Dalton companies, who are the largest colliery proprietors, and who work the great bulk of household coal, having large capitals employed from which they ought to derive a good annual revenue, especially under the existing large demand for this sort of coal, and the present increasing rate of labour for working it, and considering the fact that the product may only last a comparitively short period. The duration of the Northern Coal Field may be estimated at under 400 years, but hereafter it will be shewn that according to the present demand all the the most valuable will be exhausted long before that time shall have elapsed, and should the estimated yearly quantity be increased accordingly it would be a still shorter period.

In former times the best coals on the Tyne were wrought at Whitley, Percy Main, Walker, Wallsend, Heaton, Bigge's Main and the several pits, Killingworth and other pits belonging to the Grand Allies, the title of an association or company formed by Lords Ravensworth, Wharncliffe, and Strathmore; afterwards Mr. Bowes, M.P., became a partner, as heir of the late Earl of Strathmore; and this firm has lately sub-leased their interest to Nich. Wood, Chas. Palmer, and Co., who are now working good household coal, next the root of the Main Dyke, at Killingworth Pit, which lies at a very great angle, 1 in 4, 3 and 2 per yard, and also at as great a depth under the surface as any pit.

Those collieries that produce the best of the household coal of the present day, namely, Lyon's Hetton, Eppleton, Elemore, South Hetton, Dalton, North Hetton, Kelloe, Haswell, Shotton, Thornley, Ludworth, Cassop, Crowtrees, and the collieries of the Earl of Durham and the late Marquis of Londonderry, are situated on an average from eight to ten miles from good shipping berths or stations where the coal is delivered with facilities for supplying the markets.

We have already alluded to the large quantities of the best coal formerly destroyed as waste or allowed to accumulate near the mouth of the pits and burnt.

This practice continued up to a few years ago, and the extent of coal thus destroyed amounted, on a moderate calculation, to near one-fifth of the whole produce. It was found cheaper to destroy them than pay rent and leading charges. There was, in fact, no sufficient demand for the coal dust as it may be termed, there being at that time very little coke required and even what were called nuts were sold very sparingly. The general supply of coals at that period exceeded the demand, and consequently it was deemed advisable to dispose only of the most profitable, those which retained their best form were hence usually denominated large. The small coal in many districts, where the Hutton seams were worked, were found mixed with pyrites, sulphur, and other ingredients which rendered them unfit for manufacturing or coking purposes. A machine for cleaning by washing them has been patented and introduced into this district by Mr. Morrison, and coke of good quality is made from them in the Wear district. Small coals were formerly destroyed in even the best districts of the Tyne although the pits whence they were obtained were only a mile or two from the place of shipment or delivery.

The following is a statement of the vend of coal from this district for the years 1851 and 1852 respectively, as furnished in a report of the Coal Trade Committee at a meeting of the representatives of collieries held in the Assembly Rooms, Newcastle-upon-Tyne, on the 16th of August 1853:—

	LONDON AND COASTWISE. TONS.	OVER-SEA. TONS.	TOTAL. TONS.
1851	5,707,736	2,180,070	7,887,806
1852	6,000,337	2,334,546	8,334,883
Increase in 1852	292,601	154,476	447,077

A review of the vend for the past ten years gives the following results, taking the quantity in each fifth year:—

	LONDON AND COASTWISE. TONS.	FOREIGN. TONS.	TOTAL. TONS.
1842	4,548,823	1,425,125	5,973,948
1847	5,921,037	1,806,637	7,727,674
1852	6,000,337	2,335,546	8,334,883
The above is without home consumption, which was in 1852 more than			6,000,000
		Tons in 1852 ..	14,334,883

Increase in ten years ..... 2,360,935 Tons
Increase per cent. ..... 39·5
Increase per cent. per annum 2¾

			TONS.	
In the last year, 1853, coals sent to London alone			4,023,156	
Coastwise, export, and foreign			4,300,000	
Home consumption			6 000,000	upwards.
		Tons Yearly ..	14,323,156	& upwds.
Deduct sundries sent from other places than Durham and Northumberland to London:—		TONS.		
From Southern Counties by railway		629,712		
Do. Do. Do. canal		24,017		
	TONS.	653,729		
Do. by vessels from Yorkshire	24,247			
Welsh	82,542			
Scotch	13,611			
Liverpool	180			
Small coal	31,778			
		152,358		
			806,087	
Leaving from "Our Coal Field" in Durham and Northumberland Yearly		Tons	13,517,069	upwards.

NOTE.—In the year 1700, the quantity of coal sent to London market was only 329,000 London chaldróns, at 28 cwt. per chaldron, equal to 460,000 tons, used yearly at that period.

This great increase is irrespective of the large quantity of coals now converted into coke for inland consumption and of the augmented home consumption arising from the local manufactories, in reference to which it may be remarked that the price of small coals has lately been raised, but only in what is considered a fair advance.

It is somewhat singular that the coal south of the Wear should formerly have been worked in the Main Coal Seam, when the Hutton Coal Seam lay only 250 feet below, exceedingly fine in quality, about 4 feet 8 inches in thickness, nearly free of extra feeders of water, and approachable at a cost for further sinking of about £500. The Main Coal Seam is more expensive to work than the Hutton, and the produce does not sell for so good a price. The Low Main Coal Seam, below the Main Coal, is like the Five-quarter above it, and more expensive to work. During the last few years, when prices were low, it is doubtful whether the trade of the district could have gone on if the Hutton Seam, so easily and good to sell, had not been easily wrought. The formation of a public railway company within the last few years, has brought other large coal fields in the market, and competition has been further extended by speculators adventuring money in hazardous undertakings, which injuriously interfered with legitimate colliery concerns.

The Great Northern Railway doing the like unto London, and delivering to consumers at a low price, in consequence of the quality not being generally so good as our Northern Coal Field; Wallsend Coal, which,

when sent by the Great Northern Railroad, has a longer distance, consequently our Northern Coal take the advantage they have, by sending to London and coastwise, and all other foreign ports by shipments from ports on the east coast.

At Blackboy, Tees Wallsend, Eldon, Coundon, and Adelaide, the coal was worked in the Upper Five-quarter Seam till about the year 1830, and was generally considered better than the Main Coal, which is now proved to be better and finer there than that of the Hutton Seam.

The Main Coal Seam was easily approachable without extra water power from the Five-quarter, like the Hutton Seam under the Main Coal on the Wear; yet, when it was sunk to at Blackboy, in 1829, and tried, it was rejected by the fitters at Stockton, who gave preference to the more tender coal of the Five-quarter Seam. There was not a shipping place at Middlesbro' at that period. The Etherly Seams, which is a pecularly durable coal, free from sulphur, which are good coal, the Beaumont, the Five-quarter, and the Stone Coal, either combination of which or the Brockwell Seam (forming the Main Coal), which is from 40 to 45 fathoms lower, lie considerably under the main coal of the district, where the seams are separated, crop out westward of Witton-le-Wear, from which circumstance it may be assumed that they are to the eastward, though dipping low towards Ferryhill and Thornley, and under the red sandstone at Hartbushes, the Hesselton Dean, and south towards Hartlepool. At none of these places have the seams been proved of good thickness or quality where sunk or bored to.

In the large district east of Blackboy, south of the Butterknowle and Hett Dykes, to a line running towards Wynyard or Newton Parks, and towards the mouth of the Tees, the upper seam, as far as has been proved, are found to be of inferior quality; and no good Hutton Seam or any other, has been found to be good, so far as this district is proved south.

It is probable that the lower seams exist at their greater depth, notwithstanding the limestone and the red sandstone lie at considerable thickness above them; but the depth of these lower seams must be both great and uncertain, that few speculators will be induced to incur the expense of approaching them, at least not until the pits sunk west of the red sandstone and on the borders of the limestone have been worked out in the seams to which they now afford access, and also until the patches are are occupied and worked where the seams are known of sufficient thickness in the doubtful districts.

It may be remarked, that there are very few pits even sunk in the

limestone, most of them being upon the border of it, as East Thickley, Eldon, Blackboy, Coundon, Westerton, Ferryhill, Cornforth, Coxhoe, Cassop, West Hetton, Crow Trees, Heughhall, Cassop, Shadforth, Sherburn, Little Town, Haswell, Pittington, Moorsley, Hetton, Eppleton, Downs, Houghton, Newbottle, East Harrington, Pensher, Manor Wallsend, St. Hilda, Jarrow, and Harton, this latter working extensively near St. Hilda, in the county of Durham, and Whitley, and several others in the county of Northumberland, are now laid in.

The only pits that may be said to be sunk in the limestone are at Haswell, Ludworth, South Hetton, Dalton, Seaham, and Seaton in the Hutton seam district, Thornley, Shotton, Castle Eden, Wingate Grange, South Wingate, Trimdon Grange and Trimdon Bishop Middleham, Chilton and Ferryhill new pit in the Five-quarter Seam, south of the Hett Dyke, are all in an expensive and more precarious district, as regards the Hutton Seam.

Castle Eden, South Wingate, and Hartbushes are perhaps the worst of all, so far justifying the inference that the coal under the limestone approaching the red sandstone and the sea towards Hartlepool is very far from satisfactory. The pit at Castle Eden and Hartbushes is about 15 miles east from the west outcrop of limestone at Thickley, bordering on the outburst of new upper red sandstone. At Haswell New Pit, the coal is under the limestone, for about two miles, in a direct course eastward from the outcrop at Sherburn Hills, which is about two and a half miles from the city of Durham, but that is not the old Haswell village visited by Mr Smith, whose opinion that good coal would be found in all places under the limestone has been so often quoted in contrast with the more cautious expression of opinions by other eminent colliery viewers in connection with the district. If Mr. Smith had taken the course from Durham through Whitwell, about two aud a half miles, and put pits down there, or at the outcrop of limestone about three miles, he would have found the Hutton seam inferior, and none of it good under the limestone, or in the workings even north of the Hett Dyke. Then, if he had taken the line from Durham, through by Pittington, Halgarth, and Little Town to Elemore Hall, and further on to Low Old Haswell, a distance, from Durham, of about five miles, he would have found between Pittington Halgarth, one mile east of Belmont Station, and near Sherburn Station, a narrow strip of land extending, uncovered with limestone, for about two or three miles to Old Haswell, which is probably the place to which he applied his conjectural opinion, where the limestone puts on eastward.

In fact, the good Hutton seam really found under the limestone in the County of Durham is of very small extent, not more than a few miles square, or less than one-fifth or one-sixth of the area of the limestone County of Durham, under which the coal has been estimated, and the remainder five-sixths to be precarious as to profit, and so thin in many places as to be unworkable.

This verifies to a great extent the opinion expressed by the late Mr. Buddle, and in my opinion a very different result would not be arrived at even taking into account the small portion of good coal that may be got under the sea. After Mr. Buddle, in the year 1818, succeeded Mr. Arthur Mowbray, in the management of the extensive concerns of the late Marquis of Londonderry, the Hutton seam then became, although at greater depth, more extensively worked and its qualities better known. The coal from that seam sold for many years at the place of shipment at 36s. 6d. per chaldron, equal to 13s. 9d. per ton; and that price continued up to 1827, when the price of best coals was reduced 4s. per chaldron, making 32s. 6d. per chaldron, or 12s. per ton.

The Main Coal Seam was formerly, and about that time, called "Ducks" (I believe, after an individual of that name, who was in humble circumstances when a boy, near Durham, but afterwards acquired great wealth, and became Sir John Ducks,) and occasionally second quality, called Eden Main, at the colliery of Lord Londonderry, then Sir Harry Vane Tempest's, but at Lyon's North and South Hetton, when opened out there, it went under the name of Lyon's Main, the late John Lyon, of Hetton Hall, being one of the principal lessors of these collieries. The lessees of Lyon's Hetton Colliery hold largely of him, both of this Main coal and Hutton seams, as well as others in that district.

Hutton Seam.—This district comprises the following Collieries:—Ryhope, Silksworth, Murton, Dalton, Seaham, Seaton, Pensher, Houghton, Elemore, Pittington, Brasside, Heughhall, Shincliffe, Rainton's Hazard, Dunwell, Moorsley, North and South Hetton, Newbottle, Ludworth, Broomside, Whitfield, Lumley, Kepier, Shadforth, Cassop, Easington, Hetton, Down's Elemore, Little Town, Belmont, Whitehouse, Crow Trees, Grange, Arbour House, Old Durham, Alexandre, Adventure, Meadows, and Revolution Pits—estimated area 55·25 square miles—and greatly worked westward.

Blackboy or Tees Wallsend District.—This is a small patch of good house coal in the seam at the south western portion of the coal field, on the outcrop of the magnesian limestone. It is irregular in shape, and contains an area of about six miles. It includes Blackboy, Tees

Wallsend, Leasingthorne, Westerton, Coundon, Eldon, Copy Crook, Shildon, and Adelaide Deanery, greatly worked out.

Tyne District.—This a piece of good coal running along the north side of the Ninety-fathoms Dyke from Earsdon to Stella, Greenside, and Kyo, thirteen miles, averaging about one mile in breadth. It includes Earsdon, Holywell, Gosforth, Backworth, Killingworth, Coxlodge, Walbottle, Stella, and Townley Pits. At Stargate, near to the Main Dyke, at Stephen's Hall, and C. Pit at the Folley, this is also greatly worked off in the narrow scribe alluded to, which lays near to the Main Dyke, at a great angle, dipping to it at the rate of 5, 4, 3, and even 2 per yard, making it difficult to get in the underground working places where there is a large quantity of water made in workings, when workable, at so great an angle to the dip. These are the causes why there is still a small portion of this good coal left in a workable state, which, are now being worked at Killingworth, four miles north, and at Townley, six miles west of Newcastle, and shipped in the River Tyne.

CHAPTER IX.

THE COKING COAL DISTRICT.

A large portion of the district which at present supplies coal for coking purposes a very few years ago, was either altogether dormant, or only worked in small localities for sea sale, leaving the large remainder very partially worked for land sale, the district being then thinly populated.

The writer of this memoir, more than 21 years ago, when mining agent for Jonathan Backhouse, Esq., Darlington, was appointed to examine and report upon the whole of the extensive district, forming the south western portion of the northern coal field (suitable for gas and coke). After he had done so, and reported that it was extremely improbable that any considerable portion of it would be required to be opened out during the twenty years then next ensuing, there was not then any reasonable ground for entertaining a different opinion.

The public railway system was then in its infancy. The Liverpool and Manchester Railway, the second after the Stockton and Darlington, was then unopened, each of which is now in connection with nearly all the railways in the kingdom, and, by means of telegraph, with Ireland. Since that period, however, the extraordinary demand for railway iron, and the increase of locomotive engines, not only in this country but the whole continent of Europe, have caused such a demand for coke, as to have brought this district, which produces coals admirably adapted for that purpose, into active operation; and, in many places the manufacture of coke has been established as an entirely new branch of business, in which large capitals are embarked in our northern coal field. Although the coals in the coking district are got at comparatively little expense, since the seams lie near the surface, and tender to work, the cost of making coke ovens and providing for the long railway transit necessarily involved an expenditure of a considerable amount of money, and proportionally augmented the leading charges.

The district, which supplies the best description of coal for coking purposes, coloured blue on the map, is circumscribed by an irregular line,

commencing at Butterknowle and Copley Bent, the extreme Western portion of the northern coal field, and proceeding by Witton Park iron works, near to Bishop Auckland, thence along the course of the river Wear to Wolsingham iron works, across by Towlaw, Consett, where extensive iron works are established, Newlands, the Crown lands at Chopwell, Hedley, Bywell, the course of the Tyne by Mickley colliery, Stella Coal Company, collieries at Townley, Whitefield and Stella south of the Tyne, also a small portion of Wylam on the north side thereof, again across the Tyne to the Derwent, and down the Tyne to the Team river at Norwood, then south by Farnacres, Ravensworth, Lobley Hill, Marley Hill, Pontop Pyke, and the pits south of it at Brandon and Brancepeth, and again along the course of the Wear to Witton Park.

COKING DISTRICT.

This district, from the Etherly Seams on the south, to about half a mile north of the Tyne at Wylam, is nearly 23 miles in extent. It is irregular in form, and averages about 9 miles in width. Its extreme breadth on a line from Ouston to Shotley, Unthank and Conside, is upwards of 13 miles; from Burnop Flat to outcrop of coal, about 5 miles; from Sunderland Bridge to Elm Park, about 8 miles. It may be taken as averaging 20 miles by 8=160 square miles. It is traversed by two principal lines of railway—one, the Pontop and Shields Railway, formerly Stanhope and Tyne, enters it south of Pelaw, proceeds west through Pontop to Berry Edge and Mains Field near Cold Rowley, and forms a junction on Muggleswick Common with the West Derwent and Wear Junction Railway, which runs by Thornley Common, Pease's west pits, Witton Park, into the centre of the Blackboy district, and is continued by another branch to the Stockton and Darlington line, near Shildon Station. The West Durham Railway is a continuation of the Byers Green Branch, through the coking district from Byers Green to Witton-le-Wear and Woodland Collieries, a little beyond Pease's west pits. The Newcastle and Carlisle Railway skirts the northern portion of the district from Blaydon to Mickley. A branch on the south side of the Tyne, from Blaydon to Gateshead, with short branches from near Blaydon to Blaydon Main, Stella, or Carr's and also Cowan's pits. Branch from Derwent Haugh to Garesfield Chopwell collieries, and another branch by Redheugh, Team, Norwood, Marley Hill, Andrew's House, and to other collieries.

Branch Railway from Stella, near Blaydon.—It commences from the Newcastle and Carlisle line at the depot at Stella to the Stella Freehold pit, and also the Townley and Whitfield pits, near Ryton and Woodside.

Newcastle and Carlisle Railway.—Mickley, Stella, Townley, and Blaydon Main Collieries.

Pontop and Shields Public Railroad.—South Pelaw Colliery, Pelton Moor, Twizell, Stanley, South Tanfield, Stanley South, South Moor, Cresswell, Greencroft, Dipton, Brooms, Medomsley,, Old Medomsley, Carr House, Crook Hall, Burnop Flat pit, Crag Head.

Derwent Wear Junction.—Witton Park, North Ditchburn, Ditchburn, Woodyfield, Pease's West Pits, Roddy Moor, Thornley New Town, Hedley Hope.

Derwent Branch.—Garesfield and Chopwell.

Marley Hall Branch.—Norwood and Farnacres, Marley Hill Crook Bank, Burnop Field, Andrew's House, East Tanfield, Tanfield Leigh, Tanfield Moor, Harelaw, Pontop.

West Durham Railway.—Byers Green, New Field, Hunwick, Sunnybrook, Brancepeth, Bowdon Close, Jobs Hill, North Roddy Moor, and Whitworth.

Auckland Branch.—Etherly Colliery, Old Witton Park, and Stockton and Darlington Railway, see Chap. XI.

There are a few private branches of railway from Springwell, Heworth, Hebburn, and Gateshead Park Collieries, to the Tyne.

This district is surrounded by a considerable portion of coal of precarious or doubtful character, which is classed under the Fourth Division.

The seams of coal for coking purposes are in great perfection, at Norwood, west of Newcastle, in the Townley Main and Whitfield districts, in the parishes of Ryton and Winlaton, and also at Wylam and Mickley, in Northumberland, the outcrop being only a short distance westward at Bywell. The highest shipping places on the Tyne are the wharfs of the Townley Coal Company close to the Newcastle and Carlisle Railway at Blaydon for Gateshead, Newcastle, and Sunderland, where coal and coke can be sent by railway, or shipped in craft of from 20 to 200 tons. The proprietors of the Townley colliery have manufactured and supplied coke ovens with coal for a considerable time, and they have recently extended their own ovens very considerably, though not to the extent of those newly erected for the purpose of large contracts at Mickley, Marley Hill, and elsewhere, with newly established collieries for that purpose, in the same neighbourhood. They supply coke burners with coal of

finest quality, which is delivered either into ships on the Tyne, or sent elswhere by railway. In the river Tyne freights are as low, or even lower than at any other coal port on the eastern coast; the ships having carried coals to London for years, from 6s. to 7s. per ton.

The coal from this district is extensively used in the manufacture of gas, glass, for smithwork, sugar refining, and various other purposes requiring a gaseous coal free from pyrites, sulphur, and other objectionable ingredients. The Wylam colliery supplies coal and coke to the iron works at Wylam, which are carried on extensively there, and also to the Lemington iron works, the coals being conveyed along a private railway by locomotive engines. This was the first or one of the first lines of railway for this purpose in the United Kingdom. Wylam estate, the colliery, and railway, are the property of Mr. Blackett, M.P. At Wylam colliery, one of the first pumping engines was erected by Bolton and Watt, on the condensing principle, a short time after the great flood in 1771 in the Tyne, when the water broke into the pit, and it has been constantly at work ever since, without a day's rest for 40 years, except when under repairs, and that only for a day or two once a year. The pumping engine at Wylam is still a good engine, lifting tons of water per day, and has been one of the best and most economical in the trade. The rails on this road have been thrice relaid. The locomotive engines used on this line are of very simple construction, being upon the original plan of George Stephenson, Esq. These, as well as the present Hetton Colliery engines, which are of similar construction at present, lead the coal cheaper upon the private railway than any public railway yet invented.

The present Cornish pumping engines use less fuel, but at the time the Wylam engines were erected small and refuse coal was not of the value at Wylam as it has since become, fuel always being dearer in Cornwall. More than thirty years before the duties were removed (in 1831) coals were then drawn from the pits at Townley, Chopwell, Throckley, and others, by means of gins and horses; and at Brandon, near Brancepeth, now an important coal district, the gin was worked by a bull in harness, attended by a female. The only recorded instance of a woman having been employed in our northern coal mines, is in Gateshead Burial Registry, about 1705, when the daughter of Jackson, who had three pits in the first field at the head of Jackson-chare or street, was killed, with a number of the opposite sex, in the blasting of one of the pits. The street has been named after him.

At Throckley, on the north side of the river Tyne, opposite the grand

Lease Royalties, coal was worked in the Townley or Beaumont and lower seams more than half a century ago, which seams run out to the north-west. The coal was hard and bright, but it was in such little demand at that day that it was used for building houses, an entire row having been built of it. This took place about the year 1793, when the French Rulers banished the Roman Catholic priests from France, several of whom took refuge in this locality, and hence these houses got the name of the "Frenchmen's Row." The property belongs to the Greenwich Hospital. There is still a pit at Throckley for land-sale. A colliery was sunk at Callerton, in the same neighbourhood, for sea-sale; but after a considerable outlay had been sunk upon it, and in the formation of a railway to the Tyne at Bell's Close, near Scotswood, it was abandoned as an unprofitable concern; the like may be said of Fawdon and Wide Open Collieries, which also constructed a railway to the same point, to ship coals by keels, but abandoned the line after some years trial. Another railway was constructed by the same company, for half-chaldron waggons from the same collieries to another point below Newcastle, where they had formerly been shipping with full chaldron waggons, but after even this second, or rather third attempt, the Fawdon and Wide Open Collieries were abandoned. It was at Throckley that William Brown, a mining engineer, produced his wooden-man to hew coals, but the difficulty of getting it to obey orders and execute the required work, were found to be greater than anticipated. We have now an an excellent machine for cutting coal, invented and patented by Mr. Peace, of Haigh Colliery, near Wigan, at the extensive collieries belonging to the Earl of Crawford and Bellcaris, which is worked by means of one of the steam engines for to get high pressure air into a small pipe to work it, and promises to supersede, in a great measure, the present mode of working, for which Mr. Brown failed to find an effectual substitute in his time, (above 80 years ago,) and which many have turned their attention to without success. As I have seen Mr. Peace's machine in operation, working up to six-horse power, I have every reason to believe it will be successful, as it comes into so small a compass as a yard square.

A new pit, 12 years ago, was sunk in the property of the Duke of Northumberland, in the low grounds on the south side of the Tyne, opposite Wylam, Horsley-wood, east of Prudhoe Castle. A great number of hazel nuts were found here in the quicksand, at a considerable depth below the surface, shewing that these grounds had been in the bed of the river in former times. This colliery has been laid in for some years, not having been successful to the proprietor. The coal pro-

duced from collieries in this neighbourhood at present and at several of the collieries above-named, is of such fine quality that the small coal when screened is like pulverised corn; and, it is found to make coke of the very best quality, as the screened coal can only be obtained in limited quantities, when making household coal, the larger or unscreened coal is resorted to for coking purposes; at Marley Hill, the blocks being too large, a machine was resorted to for the purpose of breaking them into what has been found the most convenient size; where the seams are of suitable quality, at other collieries, when the small coals are not suitable from admixture with pyrites and other ingredients, the coal has to be washed by means of an expensive process.

Large quantities of coke are exported annually to Spain and various other parts of the world; and there is no doubt a much more extensive trade may be done, under more favourable circumstances, by cutting the coal cheaper than at present, and lessening the manual labour by means of machinery, as has been obliged to be done in factories, as the facilities for shipment, both on the Tyne and the Wear, are very great, while freights to all parts are generally moderate.

There is no doubt that we are able to compete with Belgium, Prussia, Austria, France, Russia, or any other continental state, where coal may may be found, even though these countries are a great distance from our coal districts and may have labour at half the price, we have to pay for it here. Many of these states have abundance of coal seams hitherto only partially developed, but which may be brought into play by means of railways and mechanical power to assist labour (if constructed by Government,) and the great demand created by steam vessels engaged on long voyages. The manufacture of iron going on in continental Europe does and will require large supplies of coal. The price of coke, and coal for the purposes of making coke, has been very low in this district for the last twenty years, up to June, 1853, so as to have rendered the trade, except under peculiar circumstances, far from remunerative. Since that period, however, there has been a decided improvement, and at the present, prices are nearly one-fourth or twenty-five per cent. higher than they have been for the previous ten years. There is still a good and increasing demand for coal and coke, both in this country and in the general market of Europe and America.

CHAPTER X.

THE STEAM COAL DISTRICT.

The steam coal district of the North of England lies to the north of what is called the Ninety-fathom Dyke; and, like the household coal district, is only of very limited extent. It extends from about two miles north of the Main Dyke to about two or more miles north of the Wansbeck, a distance of nearly nine or ten miles, and from the coast westward about five miles. It is oblong in form, and the area is about 42 or 50 square miles.

A line from Hartley to Seaton Burn pits and Blyth, along the York, Newcastle, and Berwick Railway to Morpeth, and by the course of the Wansbeck to the sea will enclose the best steam coal district. Steam coal is worked to the north of the Wansbeck, but the coal is of less value and inferior quality; and the district, to a certain extent farther north, in which it lies may be classified as belonging to the Fourth Division.

The best steam coal district is about the same size as the unwrought household district. Both together are not equal in area to the coking coal district, which is again smaller than the aggregate of what is included in the fourth division.

The collieries supplying the best steam coal are the Cramlington, Netherton, Seghill, Bedlington, Seaton Delaval, Cowpen, Blyth, and Seaton Burn. The greatest portion of the coal from the steam district is shipped on the Tyne, by which considerable expense in haulage, both on public and private railroads, is incurred in consequence of the length of lead. A portion is by short lead shipped at Seaton Sluice and Blyth; but the present facilities of that harbour is not adequate to meet the requirements of the district, as vessels of large size cannot load there.

The coal district, to which Seaton Sluice and Blyth have capabilities would form the natural outlet, occupies, it is calculated, an area of not less than 15 square miles. A project for the improvement of Blyth harbour, the construction of docks, and the formation of a railway in connection therewith, and uniting with others in the neighbouring district, is before the public. It is proposed to form a company for the purpose of executing the work, with Sir Matthew White Ridley,

Bart., as chairman. The docks have been planned by Mr. James Abernethy, C.E., London, and when his plans are fully carried out, they will, no doubt, be of great benefit to the coal district.

Notwithstanding the great distance which the coal district lies from places of shipment on the Tyne, the cost of transit is extremely moderate, being, according to distance, threepence per chaldron, or say 1¼d. per ton per mile, including shipping charges. The distance is from eight to fourteen miles, being an average of about ten miles in carriage; and the average cost is about 2s. 8d. per chaldron or 1s. per ton, the entire average distance from those collieries.

Cramlington Colliery may be said to be the oldest and best of the steam coal pit districts, and Seghill is next to it. A large capital was sunk in each of these collieries in the year 1822 and 1823, in the expectation that coal would be found there suitable for household fire purposes, as good or valuable as the Wallsend seam had been previously, or, at any rate, as good as the Backworth and Killingworth Coal.

However it turned out otherwise, and it was somewhat surprising that the very seams of coal that were passed by at that time, because they were considered not suitable for household purposes, and therefore not wanted, and to be not worth the expense of excavating and bringing to market, are now being worked, and bring the best price in the market for good steam coal, with profit to the proprietors. The great demand which has sprung up within the last 20 or 30 years for this description of coal, preferred for steam purposes, has created a most important change in the character of this branch of the trade.

The second district of steam coal lies further to the north or from Widdrington Castle towards the River Coquet, near Amble Harbour, where the collieries of Ratcliffe and Brown Hill have been sunk. The former about a mile from the shipping, and the latter about three miles, and two miles from the York, Newcastle, and Berwick Railway.

The Harbour of Amble and Ratcliffe Colliery were both projected at the same time, and prosecuted with spirit for some years, but it is doubtful whether either have been lucrative undertakings up to the present time, the opposition having been so great, while the annual vend has been so small, and the selling prices of late years so low.

This district being situated close to the limestone or millstone grit seams, is of a very uncertain character, laying in patches or isolated basins. The Brownhill Colliery commenced about twenty years ago in Earl Grey's property, has lately come into the hands of an enterprising party who will probably work it with vigour, but previous to this time it

has been much impeded by underground difficulties which have required capital to overcome them. These two collieries have now, in addition to the Harbour at Amble, an outlet to the Tyne by means of the York, Newcastle, and Berwick Railway, at a distance of about twenty miles, which is greatly in their favour.

To the west of those two places the coal is only worked for landsale.

From the river Tyne northward the surface of the earth in the steam coal-field is very level, and not on an average more than 100 feet above the level of the sea.

The York, Newcastle, and Berwick Railway almost upon a level, runs through it from the Killingworth station to the Warkworth station. The proprietors of Seaton Delaval Colliery, which lies about half-way between the sea and the outcrop, and may be considered in the centre of the steam coal district, have sunk several pits nearer the sea. In several of these pits the seams of coal are so thin as not to be considered workable at a profit, proving that the coal towards the sea, in certain patches, is thin and inferior here as well as further northwards, in places where tried. These thin coal pits had to be abandoned in consequence of the thinness of the seam, and some of them still standing unworked, others were drifted into thicker coal, at a great distance from the pit, which took a long period of time and great expense. These pits, which were unsuccessful, were sunk by the late John Straker, Esq., of Cramlington, the same gentleman also sunk Cramlington Colliery.

There are pits sunk in this district to the rise as well as to the dip. Almost all the coal applied to steam purposes lies in bags or basins, the extreme edge being the thinnest part. These seams have been apparently nipped by the roof and sill coming close together for several hundreds of yards in breadth in many places, thus reducing the quantity per acre, and making it much more expensive to work.

This thin coal extends over a considerable portion of the steam coal district, and the principal proprietors who prefer to work the thick seam, varying from 5 feet to 6 feet 6 inches in thickness, are leaving the thin seams to be worked at some distant day when even they can be made profitable. Considering the extent of these thin seams, and the extent of precarious district, it is obvious that the average thickness throughout the steam district cannot be taken so high as might have been reasonably expected some few years ago, from what we now see in the districts where the high seams prevail, but probably from a foot to two feet and a half less, which, when taken into account, will make a considerable reduction over the whole area.

CHAPTER XI.

DOUBTFUL OR MORE PRECARIOUS DISTRICTS.

We now come to treat of the patches in the coal field, which lie scattered in various places, and which we group together under a fourth sub-division, as comprising some portions which have not been proved, but where the coal is doubtful or supposed to be inferior, and hitherto not workable at a remunerative price, or that have been proved and abandoned, or the works being carried on without profit.

On the south side of the Main Dyke, opposite Killingworth, towards Wallsend, at Wallsend and at Percy Main, the Main Coal Seam of the Tyne was at one period very valuable; but now the principal portion of it is nearly worked out, and the district has become almost abandoned.

On the south side of the river, at St. Hilda, Davy's Manor .Wallsend Pits, near the Brandling Drops, Jarrow, Tyne Main, and Gateshead, the best coal is entirely exhausted; and at Heaton, on the north side of the Tyne, the owners are sinking the shaft lower, in expectation of meeting with a steam coal seam. Also, there are Walker, Spital Tongues, Elswick, Benwell, Callerton, Bell's Close, Fawdon, Coxlodge, and Montague Main, all in an unprofitable state.

Opposite Bell's Close, on the south side of the Tyne, at Swalwell, Axwell Park, and other pits, sunk a few years ago near the seam, down to Jarrow, the district, which is north of the Heworth Dyke, is doubtful or inferior, the coal measures lying at a considerable depth below the surface and the level of the sea.

The coal worked at Harton Colliery is not remarkable as a household coal, nor is it exactly a steam or coking coal, it has been sunk a long time, and at a great expense, and although close to the shipping place incurs a considerable outlay in working; the seams being deep, have hitherto not brought fair prices, considering the large capital invested. This pit lies near to and between St. Hilda and Jarrow.

The deep coal measures extend southward along the coast, but they have not been reached between Harton and Monkwearmouth Collieries. These two collieries are the deepest in existence below the level of the sea,

that at Monkwearmouth has been sunk to the Hutton Seam, a depth of 1800 feet, through the magnesian limestone. It was about 20 years in sinking, at a great outlay, without any return of interest. The Hutto coal seam at this Colliery is not so first-rate as in other parts of the district where it is worked, being tender and friable, in consequence it sells at a less price than coal from the Londonderry pit, the Hetton Haswell, South Hetton, North Hetton, the Earl of Durham's, Wingate Grange, Ludworth, Kelloe, Tees Wallsend, and Adelaide Wallsend.

From Monkwearmouth pit towards Pensher, there are Chatershaugh and Biddick Collieries, where the Hutton seam is also tender, and is supposed to partake of the same character. Immediately southward of the Wear to Ryhope, eastward of a line from Pensher, nearly to Dalton, Seaton near Seaham, the Hutton seam has been proved to be good, but rather more tender than at Hetton and Haswell.

We may take the Whinstone Dyke at Hett from the Sea at Easington, through between Shotton and Haswell Pits, and between Ludlow and Thornley Pits, by Hett, as the line at which the Hutton seam is cut off to the south, and on to Cockfield Fell.

The Five-quarter seam at Thornley, Trimdon, and some other collieries in that neighbourhood, on the south side of the Whinstone Dyke, produces good household coal, though it is more expensive to work than the Hutton seam.

In the Hartlepool District, as shewn upon the plan by the pink shading, the magnesian limestone is overlapped by the new upper red sandstone, which crops out in a sweeping direction from Hartlepool West Docks to Hutton Henry, southward to Hartbushes, South Wingate, Butterwick, northward to Holdfirth in the neighbourhood of Bishop Middleham, thence to the south-west of Bradbury to Isle Bridge between Woodham and Windlestone, and then in a south-easterly direction towards Aycliffe.

Seven miles to the southward of the Tees mouth is Redcar on the Sea, where it was proposed at one time to form a Harbour of Refuge. The Cleveland Hills, with their treasures of ironstone, commence and extend over thousands of acres, about six miles south-west from Redcar.

Between the cropping out of the new upper red sandstone and the Butterknowle Dyke, in a distance of about four miles, a great number of collieries have been sunk, and large capital expended to little profit.

Lord Howdon's, Wingate Grange, and the two Trimdons, though producing good coal, have yet been so costly that they have been either sold or valued at a tithe of the amount expended upon them by their original

owners. They are worked in the Five-quarter seam; and, if the working operations had been judiciously conducted, some of these concerns might have, before this, yielded satisfactory returns for the original owners; but which have proved much more so, upon a smaller outlay of capital, for the new owners. There is a good stripe of coal in the Five-quarter seam here and there, from Wingate Grange to Trimdon and Kelloe, averaging about a mile in breadth, and altogether about three miles in length. The district referred to embraces the following collieries, viz:—Castle Eden, South Wingate, Mr. Burdon's Castle Eden, Garmondsway, Comesforth, Bishop Middleham, Thrislington, Ferry Hill, Mason's Chilton, Mainsforth, Merrington, Middridge, Thickley, Middridge Grange.

A somewhat similar district, hardly broken into as yet, to that above described, lies between the Butterknowle and the Hett Dyke.

The Collieries of Cassop, Crow Trees, Heugh Hall, West Hetton, Coxhoe, and Clarence Hetton, six in number, are sunk upon the outburst of the limestone, just within the edge of it. They produce a good coal from the Five-quarter Seam.

Lying to the westward of the six collieries just mentioned, there is a patch, about two miles and a-half in width, and six miles in length, terminating at Whitworth, which is of a doubtful character, or generally considered to be indifferent, and consequently avoided by capitalists and speculators, at the present day. Deep bore-holes have been sunk down at Hett, without any brighter prospects.

About two miles west of the cropping out of the new red sandstone, there is a district of good coal, which has been brought into the market within the last few years, and from which considerable advantage to the owners may now be fairly expected, notwithstanding its great distance, upwards of 25 miles, from the place of shipment on the Tees. This district includes the Collieries of the Blackboy, Tees Wallsend, Eldon, Adelaide, or Shildon, Coundon, and Westerton Deanery, near Coppy Crooks; they are situated on the south of the Butterknowle Dyke, and are bounded by the Bishop's Park and the river Gaunless, on the west. This small district produces peculiarly good coal in the Five-quarter and Main Coal Seams, the former of which crops out near the Gaunless, and the Main Coal becomes deteriorated in quality as it approaches the surface, near to Bishop's Park, Thickley, Middridge, Coppy Crooks, and Brusselton Bank Top. A Lead vein puts into the Five-quarter seam in the Blackboy, Coundon, and other Collieries; it is of very pure quality, about three inches in thickness, and it is a singular instance of lead being met with in

the coal measures. Good coal is produced from the lower seams at West Auckland, St. Helen's Auckland, Woodhouse, and other places in that neighbourhood, and the same seams continue further west to Evenwood, Little Gordon, Norwood, Stoneylodge, West Tees, Lunds, Cockfield Fell, Butterknowle, Copley Bents, Lowton, and Cragg's Carr, the Coal lying close to the Whinstone Dyke, and cropping out further west at Woodlands.

Evenwood, Norwood, Gordon and Cockfield Fell Collieries have been relinquished.

CHAPTER XII.

GENERAL REMARKS ON THE DISTRICT.

SUMMARY OF DISTRICTS.

		Sq. Miles.	Sq. Miles.	Sq. Miles.
	I. *Household Coal.*			
1	Good Hutton seam	9·5 × 7·5	=71·25	
2	Blackboy District		6	
3	Tyne District		13	90·25
	II. *Coking District.*	22 × 9	=198	198
	III. *Good Steam District.*	9 × 55	= 49·5	49·5
	IV. *Fourth District.*			
1	Inferior Steam Coal	12 × 4	= 48	
2	South West Do.		29	
3	Do., next the Sea	3·5 × 15	= 5·25	
4	North of Tyne to the 90 Fathom Dyke	13 × 3	= 39	
5	Between Tyne and Wear	10 × 6	= 60	
6	South of the Wear.....	6 × 3	= 18	
7	Tender Hutton Seam West.....	6 × 3 + 2	= 20	
8	North of the Dyke	6 × 1	= 6	
9	Between Hett Dyke & Butterknowle		= 60	
10	South of the Do.	15 × 3	= 45	
11	West of Limestone Do.	12 × 3	= 36	366·25
		Total square miles		704

Measurement in Sections.

South	28 × 5	= 140
Do., ...	20 × 12	= 240
Do., ...	23 × 3	= 69
Do., ...	17 × 9	= 153
Do., ...	11 × 2	= 22
Do., ...	5 × 1	= 5
North	5 × 15	= 75
Square miles		704

Total length 47 miles, and width (average) 15 miles=705 miles.

Taking the extreme length of the Coal Field from the Tees, on a line from Stockton to Port Clarence or Middlesbro', to the entrance of the Coquet at Warkworth, as 52 miles, and the average width at 15 miles, the admeasurement adopted by Mr. R. C. Taylor, in his American work, gives an area of 780 square miles.

Taking a section from the same line at the Tees, northward 27 miles, and westward from the Sea to the outcrop 20, gives

An area of	540	square miles.
Northward 9, West 9, ...	81	ditto.
Northward 17, West 5, ...	85	ditto.
	706	

Taking the length from a point on a line drawn north and south from the outcrop at Middridge Grange, where the coal dips under the limestone to the sea northward to Warkworth at the mouth of the Coquet, gives the length 48 miles, the admeasurement of Mr. Hugh Taylor. Then taking the average width at 15 miles, we have 48 × 15=750 square miles.

Taking a line from the same point at Middridge to West Hartlepool, and measuring direct north gives 47 miles. Then, as before, 47 × 15=705 square miles. The Author's admeasurement.

To be added—Hutton Seam of good Coal under the Sea:—

	Square Miles.
9 miles Coast × 2 Sea =	18

Good Steam Coal Seam under the Sea:—

7 miles Coast × 2 Sea =	14
Square miles	32

Which is all I would fairly estimate to be under the Sea.

Inland Coal.....	705	
Under the Sea	32	
	737	square miles.

Being total of saleable coal in the Northern Coal Field, as determined by superficial measurement.

Again,

737	miles.
640	acres equal one mile.
29480	
4422	
471680	Total acres.

The estimated average stands thus:—

Mr. Hugh Taylor	535,680	Acres.
Mr. R. C. Taylor	499,200	Acres.
Mr. T. Y. Hall	471,680	Acres.

It is not known to what extent the first two estimates embrace the quantity of coal under the sea.

Before attempting to determine the probable duration of the coal field it is necessary not only to ascertain the area of the coal seams, and their cubical contents of coal supposed unworked, but the several conditions under which the process of excavation must proceed.

A certain amount of capital has been expended in opening out pits, in the several districts of the coal field. In the Hutton or household district only a very few more pits than those at present sunk may be required, in order to excavate the whole of the good seams. These additional pits, perhaps 80 or 100 years after, will or ought to be paid for gradually out of profits, as was done at Wallsend Colliery, by including all charges whatever each year as working charges, over a period of about 70 years. This would not require any great sacrifice or outlay on the part of the present owners, who already have the royalties on lease for long periods, which could not be abandoned except at a considerable sacrifice. There is, consequently, but little room left for new speculators; and, were any disposed to enter the field where there is a chance left, they would find the expense large indeed, almost insurmountable. Besides the length of time required to reach the coal, has, in several cases, been from 10 to 20 years, during which the expenditure referred to is in progress. This of itself is sufficient to deter wealthy speculators from embarking in such undertakings, so that competition with the older proprietors, where capital is already invested, has little prospect of being successful.

The great depth to which the pits in this district require to be sunk operates as a check against the opening out of new mines, and more especially when the coal can be obtained by extending the workings of pits already in existence at an easy expense. This, then, is the district of large underground operations, and as the process of exhaustion proceeds the greater will be the inducement to coal owners to abstain from any outlay of capital that can be possibly avoided.

There is no doubt that so long as the supply of the best household coal from this district can be obtained, it will find a preference, and bring the highest price in the market. As the coal is in comparatively few hands, the supply of the market may be easily and advantageously re-

gulated, not only for the benefit of the coal owner, but that of the public generally, who seldom derive any advantage from low prices when recurring at intervals of violent fluctuation from the opposite extreme.

What would be the consequence if the whole of the coal in this district of the coal field, though the inquiry is equally applicable to all, were now dug from the bowels of the earth, and pressed upon the market? Speculating capitalists would hover round the mineral treasure like vultures round a putrid carcase, eager to engross the profit and devour the spoil. A general scramble would effect its distribution on terms ruinous to the original proprietors; and new holders would speculate not on present, but on future wants, and the impossibility of meeting them with supplies from a source thus improvidently exhausted.

The invention and introduction of mechanical excavators will have a tendency to increase the quantities wrought, and economise labour, and lower wages in some departments of mining. So far, they will have a tendency to diminish the cost, and, at the same time, extend the capabilities of production; so that diminished cost will be contemporaneous with increased quantity. If the price, to the public, be lowered, in consequence of mechanical facilities in production, the general rule in such cases, would imply a corresponding extension of consumption. Should that effect follow, and production keep pace with the increased demand, the more rapidly will the exhaustion of our coal seams proceed; but the public would be directly benefited, as they have always been, by the introduction of machinery, while labour continues in as great, or becomes in greater, demand than ever. Should prices, by any arrangement among the proprietors of coal or otherwise, be maintained, matters will go on much as they have hitherto done, in so far as the supply of the market is concerned; and the saving effected by any new and more economical mode of working will, it is to be hoped, augment the general profits of each mining establishment, besides benefiting the public. These remarks, in regard to more economically working the best or Household Coal district, apply with equal force to the Steam Coal and the Coking Coal districts, leaving the fourth, or precarious district as it may be termed, open to speculators for centuries to come; for, it would be absurd to conclude that the entire coal field will ever be completely exhausted, for, independent of the inferior coal districts, no doubt there will be left a great quantity of good coal buried up, by inundation with water, in places unknown; probable expense would overbalance the value four hundred years hence, when coal may be more abundantly opened out elsewhere, so as to undersell such partially exhausted patches, which have been left

on account of difficulties. The process of exhaustion will have been completed, for all practical purposes, when profitable excavation ceases. When such is the case, our now flourishing coal districts will fall into decadency, and the immense population which they now sustain will look for new localities, probably in distant countries. Such periodic changes have occurred every few centuries since the world began, or history affords authentic records.

With this view, therefore, in estimating the present extent of remaining available coal, and the probable period of its exhaustion, a most serious error would be committed were we to assume that as being determined by, or coinciding with the cubical admeasurement of the mineral unworked. The question is, what is the extent of coal available under the existing powers?

Then, assuming these powers to remain unchanged, how long will it be till that available supply is exhausted?

Again, to what influence and to what extent is it probable that the present powers will undergo modification; and, under such assumed or determined modification, at what period may we calculate upon the production for practical and beneficial purposes ceasing? These are complicated questions, only to be solved by careful observation and details, and not by general estimates, such as appear to have formed the basis of calculation adopted by preceding writers on the subject; which, from the appearance, when such estimates were given, only 10 or 20 years ago, a longer duration might have been expected than can now be calculated upon, in my opinion, by even more than a thousand years, as will be hereafter shewn.

Commencing, then, with what is termed the Household or good coal districts, we shall endeavour to ascertain, with as great an approximation to accuracy as the materials in our possession enable us to do, by shewing the quantity available under existing circumstances.

From the general observations introduced in the preceding chapters, when assigning to each description of coal its separate locality in the sub-division of the coal field, it may be concluded that we have almost complete proof that at least two-thirds of the best seams under the limestone, at considerable depth, even where the best coal measures are found, will scarcely turn out to be worth looking after for nearly a century to come, and, therefore, for sale, are of no value at present. Even when wrought they will have to come into competition with numerous coal districts elsewhere, with a multiplicity of pits now working to the rise in our own district, which may be in a great measure worked off before

that period, and probably become filled with water, which will render the working of the inferior seams to the dip more precarious than ever, even if they can be wrought with profit. To work any of these deep pits, where they may extend under the sea, for coal where it may be found, for it is attended with much danger, not only to the pit or pits but to the workmen who may attempt to do it, as also to many others to the rise in the seam, for if once a mishap, by cutting a trouble, a gullet, or slip dyke, should happen to set the sea into the workings, the mischief that may be done, the water being at so great a pressure, will overbalance the good by a thousand-fold. It is supposed that the water which was at the Birtley Salt Works, six miles from the sea, came by a dyke from the sea. Only two or three attempts have been made to obtain coal near the sea in the northern coal field, and on the west coast there have been two trials—one by the Earl of Lonsdale, at Whitehaven, has so far succeeded, but his neighbour, a coal owner at Workington, a short distance from him, did not do so, for his workings were drowned out and a fortune lost; and as far as we have seen coal seams in pits being wrought towards the sea, as at St. Hilda's, Whitley, and Radcliffe Collieries, the result offers very little encouragement.

Therefore the district shaded black being only a portion of what has been estimated by previous writers, as being good coal, in the Hutton seam, lying under the limestone, when the deficiency in extent, as now seen, and quality is deducted, so much of the portions south of the Hett Dyke, and at places where the Hutton and other seams are not in, or so thin as not to be workable with profit, I have no hesitation in saying, that the remainder, which has been taken into account as a good district for the best seams of coal, is of much less extent than has been estimated by previous writers on the coal fields, not only in the district alluded to, but even in the best steam coal districts, as seen by the map, in three sections, and the best part is about the same size as that of the whole coal left in the good Hutton seam district. After the whole of the seams producing the best Wallsend coal have been wrought off, which probably may be only 100 years hence, the inferior or doubtful districts will be brought into action, provided the remunerative prices at that period warrant the outlay, greater risk, and more expensive working. When these two, and the coking coal districts already in operation are taken into account, it will be seen that the immense capital now employed in the best districts, where nearly all the coal may be obtained, and bring the whole of it into the market at such a low price as may comparatively keep back the inferior coal from being resorted to until the others are exhausted,

unless there be a very large demand with good remunerative prices leaving larger profits than can be reasonably anticipated. The present profit and loss, by experience, for the last 20 years, do not warrant such anticipations; and during the last few years other coals by railway from more southern counties have been coming into competition with those from this district, and even foreign coal fields will do so in foreign markets.

The same observation may be applied, *pari possu*, to other parts producing steam and coking coals, as also household coal, as Wales, Staffordshire, &c., and stimulate the coal owners in our district to follow up all new inventions as they have for a long period past done. So that these calculations of the estimated duration of our coal field will be increased for household, as also other descriptions of coal from the counties of Durham and Northumberland, and by the opening out iron ore districts in localities contiguous to those two counties.

About one-half of the Hutton seam, producing the best household coal in the County of Durham, lies beneath the magnesian limestone. At the northern extremity of the limestone the St. Hilda's pits, formerly belonging to the late Messrs. Brandling, Davy Pit and Manor Wallsend, near the Brandling drops, at South Shields, each now laid in, Harton being now substituted by a new company instead, the shaft being sunk to a great depth, working towards Jarrow (which is also laid in), but now taken, like St. Hilda and Manor Wallsend, by the same Harton Company, which are also extending their workings towards Jarrow Pit, for an air-pit, and progressing towards Monkwearmouth, in the same royalty. The St. Hilda was sunk at South Shields, but it had not the good fortune to be wrought of late to advantage to the late owners. The same may be said of its neighbour, Jarrow Colliery, which has shared a like fate, as also Whitley and Percy Main on the northern side of the river, each of those border on the outset of the limestone, and each, like St. Hilda, have not proved remunerative, and have ceased working.

Harton, a new colliery, also sunk on the edge of the limestone, in the vicinity of Jarrow, after largely expending money for some years to open it out, are about trying what can be done in an extensive maiden district, by going southwards and approaching Monkwearmouth Pit on the Wear, while the prices during the last half-year, up to the beginning of January, 1854, have been much in their favour, being one-fourth more per ton than previously. This is now a good colliery showing the wisdom of the spirited proprietors in persevering over so long a period, for with the low prices that prevailed at the commencement, this was considered to be a very doubtful district, even from the time when

Messrs. Brandling had to do with it, at the commencement in the year 1828, and the formation of the railway to Sunderland, even up to a late period, July 1853, and to January 1854, when better prices were obtained. Since the latter period, until the present month of May, 1854, prices have been again much the same and better than for 20 years past. There is not at present encouragement to capitalists, when the southern coal-fields are delivering coal, by railway, in London, to the depôts of the consumers, still at low prices, although the quality may in general be not so good, as a proof, all sent to London by them, and from the Scotch and Welsh Collieries, by rail and otherwise, is only 806,087 tons, while the Counties of Durham and Northumberland sent 3,217,069 tons last year to the London market from the northern coal field. The outcrop of the limestone ranges from three to four miles from the sea between the Tyne and the Wear, and no pits have been sunk, except at St. Hilda's, Jarrow, Harton, and the Davy Pit, Manor Wallsend on the borders of that district till you come to Pemberton's Monkwearmouth Pit, one mile from the sea, or about a quarter of the way between the sea and the outcrop of the limestone. In Pemberton's Monkwearmouth Pit the Hutton seam, which was reached at considerable depth, with an enormous outlay of money and years of incessant labour, has not been so profitable as was anticipated, being of a tender quality. The Maudlin seam, was tried in that pit for a short time above it and relinquished. But the proprietors had royalties taken south of the river Wear, towards Tunstall, near Ryhope, a part of which is marked as the second good coal district at near that point. The coal is tender at Monkwearmouth, and continues so till it becomes a little stronger towards Ryhope, Tunstall, Silksworth, New Seaham, and Seaton to Dalton. The latter two places are sunk still further south-east in the good Hutton seam district, although the coal seam there is not so strong as the Hutton seam at Hetton, Elemore, Haswell, Pittington, Little Town, Sherburn, Ludworth, and Cassop Collieries, which is the farthest west, the good hard Hutton seam being at those places.

From Sunderland towards Pensher, about six miles from the sea where the limestone crops out, we have Biddick, Chatershaugh, and even a portion of Pensher itself, with inferior coal, the two former collieries, as well as Oxclose in the same neighbourhood, have been abandoned as unprofitable. When we look at this fact, and Monkwearmouth, six miles east, being tender, there is every reason to conclude that on the line of the Wear, from Monkwearmouth to Pensher, and from Pensher to Ryhope, there is an angle in the Hutton seam southwards, next to and including Sunderland Town Moor, of a less valuable nature, par-

ticularly as none of the upper seams at Monkwearmouth and towards Ryhope and Tunstall have been found of sufficient strength to be as valuable as the Hutton seam at Hetton, Haswell, Pittington and Little Town pits. Similar observations may be made with respect to another angular area of coal under the limestone, situated on the north-side of the Wear, from Monkwearmouth to Chatershaugh opposite Pensher, by way of Biddick and Usworth to St. Hilda's and the German Ocean on the east, from Shields to Sunderland. Again, at Houghton, a pit belonging to the Earl of Durham, sunk near the edge of the limestone to the Hutton seam, lies at a depth of 1300 feet. That was also an expensive concern, and for some years after it was sunk it stopped working, although it had as good a Hutton seam as any colliery, I suppose in consequence of its working charges being more in the Main Coal and Hutton Seams than at the Lumley, Sherburn, and Little Town Hill Pits in that district, belonging to the same proprietor; but this Houghton pit is now wrought extensively in the good Hutton seam towards Hetton and Dalton.

The Downs Pit, Hetton and Haswell, Moorsley, Elemore, Pittington, Little Town, Sherburn, Shadworth and Cassop Collieries, and it may be said Ludworth, are all sunk on the verge of the limestone to the Hutton seam, which continues towards the sea under the limestone in a state of great perfection, but nevertheless there is plenty of room for changes to occur between these pits and the sea, since they have not wrought the seam much more than about a mile in that direction at any of these pits, except Seaton, Dalton, and Monkwearmouth; and we have proof of such an occurrence as coals thrown unexpectedly thinner as at Seaton Delaval Colliery, Northumberland. Other places, even the Hutton seam itself south and west of Durham, westward on the Tyne, to as great extent both in thinness and inferior quality; although in what is called the good Hutton seam district, it appears, as regards its thickness and quality, to be so defined as to be without a doubt.

Southward of the Hett Dyke the quality is good in the Five-quarter seam, which is worked at Cassop, Heugh Hall, Crow Trees, Kelloe, West Hetton, Coxhoe, Bowburn, and Clarence Hetton, all which are situated between the Hett Dyke and the edge of, or bordering upon, the limestone, including Thornley, three miles to the east of the outcrop, and Shotton, about other three miles to the eastward, all as first household coal. The coal becomes precarious and all the seams thinner on the south side of the Hett Dyke, except this district of good Five-quarter, which keeps its thickness, for a distance of several miles from the sea to a few miles westward between those dykes. At Shotton Colliery a

drift was made from that pit north through the Whinstone Dyke, some hundreds of yards, in order to prove the Hutton seam, where it was found hard and of good workable thickness. Instead of working it at the Shotton Pits, they are working the Five-quarter seam, which is found an expensive coal to work, although good. South of the dyke, the Hutton seam was found, after drifting through the Hett Dyke, to be good, being, in fact, the same as was worked by the same parties at Haswell, and the Thornley Coal Company at Ludworth. From this point, on the Hett Dyke, the Hutton seam continues excellent and hard, northward to Elemore and Moorsley, and also eastward to South Hetton, Hetton, and Houghton-le-Spring, thence east to Dalton, belonging partly to the same owners, at south Hetton and eastward to Seaham and Seaton new pits (close together), the first belonging to Lady Frances Ann Vane Tempest, representative of the late Marquis of Londonderry, the other Seaton Pit to part of the Lyon's Hetton Coal Company and the Earl of Durham. The Hutton seam becomes a little more tender as it approaches the sea. The seams above it at Dalton, Seaham, and Seaton in the eastern district, are not to be depended upon or looked forward to as at Hetton, Haswell, Elemere, Pittington, and Little Town, yet they are of great importance, having so short a distance to lead their coal to the shipping port.

The enormous amount of capital frequently expended in sinking a single pit, forms a serious obstacle to speculative undertakings, as may be illustrated by one or two examples. The sinking at Dalton, through a considerable thickness of limestone and watery quicksand, cost its owners, it is said, £300,000. The Pits at Seaton and Seaham, taking all expenses into account, will probably cost the same sum before they are got into full work; and these large amounts have been expended without the parties having to construct more than half a mile of railway, in each case to join their own private lines of railway.

The first attempt made to sink a pit at Haswell was in Lady, or Sir Geo. Shea's property, where the limestone was comparatively thin, being only about 36 fathoms in thickness, then a depth of 20 fathoms of quicksand was so great and abounding in gullets filled with feeders of water, which came in with great pressure, that it greatly impeded the operations of the sinkers, and could only be kept under by the employment of strong engine power, for twelve months or more. The difficulties at length proved to be so great, that it became necessary to abandon the sinking after an expenditure of about £60,000, less the value of the materials removed, in a period extending over about two years, and

afterwards enabled them to work the coal under the abandoned pits. The new sinking pits alluded to are the present pits at Haswell, which were sunk in a field of coal, which belonged to the South Hetton Company, given in exchange for the same area of coal belonging the Haswell Company, near South Hetton pit. It may be worthy of remark, that after the Haswell sinking pit was abandoned, three bore holes were begun, and one where the present pit is had no quicksand whatever, while the other, not far from it, was left off after boring into 26 fathoms of quicksand. The third, nearer to Shotton, was found while boring to have 16 fathoms quicksand, and abandoned like the other that had 26. The present Shotton pits were then put down a little further from this place, having only 6 fathoms of sand.

The Hutton seam extends south eastward to the Hett Dyke, near the Shotton pit, where the sand was six fathoms in thickness, on which the pit was laid out double the diameter, so as to provide for various cases of tubbing if found necessary, which, afterwards, was found to have been a wise precaution. Here, as at other places, at this dyke, the Hutton seam is of less account.

In sinking South Hetton Colliery pits, which are considerably deeper than Old Haswell pit, which was abandoned, the owners were more fortunate, and they opened out a large and valuable district; both sinkings were commenced about the same period. The Hutton seam in the South Hetton Pit was reached before the Haswell sinking was abandoned, in consequence of not being able to get through the sand and water. Both these pits are situated in favourable positions, and the Hutton seam in them is of the finest quality, producing the best household coal, the owners having large and valuable royalties, all taken of different parties for nearly 40 years to come. It may therefore be stated generally, that this district of the Hutton seam in the county of Durham has been proved to be hard and good; but there is a portion beyond the outcrop of the limestone, and at a short distance within it, of good quality, but which has been wrought out. There is also a large district of Hutton seam west of Durham that may be considered very precarious.

Eastward and to the south of the Hett Dyke towards the sea, the Hutton seam becomes tender in the Wear district. North of the Wear from Pensher to the Tyne at Shields, it is coarse and inferior in quality; and south of the Hett Dyke it is thin but hard in places, as at Castle Eden, where it is worked about two miles from the sea. The district includes the following colleries:—Hartbushes, South Wingate, Wingate

Grange, Castle Eden, Thornley, Shotton, and Whitwell, at those places the seam is in. The Hutton seam continues good to a point marked black upon the plan, under the Cathedral at Durham, which may be unwrought, although Mr. Crawford has had two pits within 200 yards of it working the Hutton seam for the last thirty years, and affected the foundation of the church near to it. But the Hutton seam is not, or if so hardly to be distinguished, at Garmondsway Moor, Kelloe, Coxhoe, Clayhole, Whitworth, Mainsforth, Cornforth, Ferryhill, Merrington, Westerton, Little and Masons Chilton, Blackboy, Adelaide and Eldon, St. Helen's Auckland, Woodhouse Close, West Auckland, Byers Green, Old Park, Etherley, Cockfield Fell, Bitchburn, Butterknowle, Hunwick, and Pease's West Pits.

North of the above-named collieries there is a district where only one seam can be considered workable. It may be the Hutton seam in some places, and it is of so fine a nature, like the coking seams, as to become a coking coal. The Hutton seam, where in, crops out at the Western pits and other places thereabout, and at Langley Mill, near Durham, and below Marley Hill, north of Lintz Hall colliery, where a new pit is sinking by a London Company in a district formerly partly wrought, with one or more pits to the top seams in every field. The like was the case in other districts adjoining that hundreds of years ago, below Pontop Pike, and on the banks of the Team, the Tyne, and the Derwent, putting in again at Townley, twenty fathoms above the Townley or Beaumont seam, and is there called the "Ruler seam," where it is 2 feet 6 inches thick, of excellent quality, but not much worked, in consequence of its hardness. In my opinion this seam is identical with the Hutton seam on the Wear, as proved by sinkings and borings, showing a similarity of character, both before and after it is burnt to a cinder. That is also the opinion of another mining engineer, Thomas John Taylor, Esq.

Nearly the whole of the district towards Hartlepool and the Tees, under the new or upper red sandstone, has not been proved; but, there is little reason, from what we have seen where it is proved, to believe that any considerable extent of it consists of the best description of workable coal, or will it be speculated in, until better known districts are wrought off perhaps years to come.

The Hutton Seam from Whitwell to Coxdale, Burn Hall, and Langley, where it crops out, or nearly so, is inferior; and likewise eastward where it lies at no great depth at Biddick, and irregular at Framwellgate Moor near Durham (Edmondsley, Hedley's Crag Head Pit), close

towards Burnhope Flat where it becomes more of a Coking Coal District.

Taking the total area of our Coal Field, at 750 square miles, viz.: —

1 Household	Wear ..... 77 Tyne ..... 13 Tees..... 6	96	greatly worked out.
2 Steam (Tyne)	1st. 49,50 2nd. 23,50 3rd. 17	90	do.
3 Coking.—This district has sometimes 4, 3, 2, and only 1 workable seam over portions of it, and some parts not workable		216	do.
4 Fourth or precarious.—This may be divided into three portions:—1st., Five-Quarter first-rate household coal; 2ndly., second-rate household coal; and lastly, third-rate household coal, and various others each in equal quantities, with portions not workable at all		300	do.
5 Under the Sea, &c.....		48	not worked.
Total.....		750	square miles.

This is including part Coal District under the upper red sandstone towards Hartlepool, and about one mile in width under the sea along the coast; each district doubtful and precarious to work.

In estimating the quantity of coking coal available at the present time, we shall proceed exactly upon the same plan as has been pursued with respect to the other districts. We shall first take a defined limit of acres for average good coal, manufacturing large quantities of coke on the spot to cheapen the carriage when the distance of transit is great, and where operations will, most likely be carried on till resort must necessarily be had to more doubtful or inferior portions. This, with the number and average thickness of seams will give the cubical contents of the coal, which may be estimated as capable of being obtained after making allowances for practical difficulties. The Coking Coal District is in many respects different from any of the others. The seams lie comparatively nearer the surface, so that it is often found cheaper to sink a shaft than to extend the underground workings beyond

a certain limit. This facility of sinking shafts, with the use of public railroads, affords likewise better opportunity to speculators to embark in the trade than where the seams are deep, and expensive sinkings are required. But, at the same time, the coal royalties, over a large portion of this district, are so taken up that very few openings are presented, and these are, in my opinion, by no means of an inviting character. It may be remarked that if the annual produce of the entire coal field be taken at 13,000,000 of tons, as at present, half of that quantity is yielded by the coking coal and the fourth district, leaving the other half for the two remaining portions, the former and the latter two increasing yearly.

This description of coal being extensively used in the manufacture of iron, gas, coke, and other purposes, as the demand for these articles increase so will the demand for this coal be extended. Every additional ton of pig metal manufactured, will alone create an extra demand of nearly 5 tons of coal, and if pig-metal be re-manufactured into malleable iron, two tons more will be wanted, therefore one million of manufactured iron might require six millions of tons of coal.

The Steam Coal District may be divided into 2 or 3 portions, the best of which is situated to the south of Morpeth. The number of pits already sunk and in course of sinking, as at Cramlington, Hartford, and Bebside Collieries, in that district is, I consider, nearly sufficient to work the whole of the coal within it, and there is no reason to apprehend that any further attempt will be made to sink shafts there, although there may be two or three more made hereafter and also in the second district north of the Wansbeck. Several of the first steam collieries, as already stated, were not sunk for the purpose of working that description of coal, which they now yield in such perfection and to such an extent, but in the expectation of finding in that district, coal the nature of good house coal, similar to the wrought out coal seams at Wallsend. There was not at that period so extensive a demand for steam coal as in the present day; but the development of this branch of industry and enterprise was rapid and extraordinary, and the coal in this district was found to be admirably suited for that purpose, and hence its marketable value. This demand for steam coal will go on increasing for many years to come, so as to work off this now circumscribed, cheap, and good district more quickly than ever expected.

But, at the same time, other parts of the country are coming into operation, and already supply coal by sea, for steam purposes, to a certain extent. In Wales there are many patches of excellent steam coal, and Yorkshire, Lancashire, Derbyshire, and Stafford-

shire afford a constant supply to the manufacturing establishments in these counties or localities near the same. In Scotland, besides supplying the local demand, there are part sent by ships, particularly from Troon, a good harbour belonging to the Portland Family.

The duration of the steam coal district will be included in the chapter on that head.

This Northern Steam Coal District, which is called the third section of this coal field, will yield, for many years to come, (when prices warrant,) and has yielded a small quantity worked in two or three pits. So that although operations are carried on at three or four places, the concerns have held out little inducement for others to do the same. The number of pits in this portion of the steam coal district is not therefore likely to be increased in competition in the less valuable coal seams until all the good steam coal is wrought out, in the southern portion, and other coal districts failing to meet the present and increasing demand which may be expected to arise. For it is clear where a good district, having pits and machinery already planted over it, and the like below, will always have the advantage over those of less value and more expensive to work and take to market, and when prices are low and profits small (if any), a little reduction in price might make one unprofitable, while the other may be just clearing its way.

NOTE.—An Appendix will be annexed explaining the different average thickness of the various workable coal seams in the different coal districts alluded to heretofore.

CHAPTER XIII.

PUBLIC RAILWAYS AND DOCKS.

The capital invested in the coal trade of the counties of Northumberland and Durham, in private railways, drops, waggons, coke ovens, and other adjunctions of the mine, has been satisfactorily ascertained to amount to about £13,000,000, which sum may be said to have been expended by the coal owners of the district, solely for the purpose of conveying the produce of their mines from the pit's mouth to the place of shipment. But a much larger amount of money would have been required had it not been for the existence of public companies investing capital in undertakings of a speculative character, and constructing railways not only for coal but general merchandise and the conveyance of passengers. The sum thus invested in the counties of Northumberland and Durham can be only proximately ascertained. Some of the railway companies provide waggons for the conveyance of coals along their line, charging the coal owner a moderate rate per mile for long distances, which arrangement relieves many of the coal owners from so large an outlay as would otherwise be required. In other respects these public companies are of great benefit to the coal trade, by developing its resources, and opening out distant inland markets that would otherwise be inaccessible, except at great expense.

Public docks stand in the same relation to the coal trade of the district as public railways. They are constructed without any special cost to the coal owner, are most useful for inland traffic, and they also afford him when the ships are ready, of placing coals on board immediately on their arriving at the staith or drops without waiting for a rising or falling tide. The amount of capital embarked in undertakings of this description, as well as that invested in public railways, or at least a very considerable proportion of it, ought to be added to the sum already stated as capital invested in the coal trade of the district, over and above that expended in sinking pits and prosecuting mining operations.

Of the amount of capital invested in public railways, docks, and other works in immediate connexion with, and dependant to a large extent if

not entirely upon the coal trade, it is very difficult to form an estimate. The construction of many of our public railways involve gigantic works, such as the High Level Bridge over the Tyne at Newcastle, the Tubular Bridge over the Menai Straits, between Wales and Anglesea, and are works which only an Englishman had the ability to contrive and the nerve skilfully to execute. The following estimate may be accepted as an approximation. It is possible one-half more of the amount of the £13,000,000 might have been required in being expended by the Coal Owners, in case Public Companies had not made the amount of accommodation they have done for the Coal Trade in this district, in this case the capital required might have been 20 million pounds sterling, to answer for the present quantity, or even a greater yearly quantity, say 20,000,000 tons per annum; but if this one-third is saved in capital the Coal Owner has to pay for it in railway dues as interest upon the same to those Public Companies who find the extra capital, which is greatly to the advantage of the proprietors of royalties that are at a considerable distance from the shipping berths, or place of sale, and which might have long lain dormant had those public companies not removed the produce from the same, which is done for about ¾d. a-ton per mile, and in some cases shewing favour to the more distant coal workings, by charging the same amount for conveying 36 miles as they do 26 miles, on purpose to get enlarged trade to their railways, by the produce of distant coal districts, while other Railway Companies charge so high for short distances, that they lose the traffic of coal nearly altogether; besides, allowing millions of tons to be sent to market from other districts, which they might get a full share of, seeing that they have the article to produce by the same railway within six miles of the shipping berths. Hitherto, the Newcastle and Carlisle Railway, rather than reduce the dues for short distances, and taking hold of all the produce, 1,000 times more than they now have, which is now kept back, or conveyed by River Craft, appear to prefer projecting Branches to their Main Lane.

CHAPTER XIV.

THE COAL FIELD IN SECTIONS.

The lineal boundaries of the Northern Coal Field are described in the opening chapter of the present memoir, and in a subsequent chapter a similar description was given of the different districts into which the coal field is subdivided, according to the characteristic differences in the nature or quality of the mineral found. Thus one district was described as producing household coal, another as yielding coal for coking, gas, and the manufacturing of iron, a third as supplying steam coal, and the fourth as comprising a sort of medley, scattered in patches over the entire coal field, not confined to any particular quality of coal, or yet yielding any description of coal in profitable perfection, and in which adventure is rendered precarious and uncertain.

In the present Chapter it is proposed to divide the coal field into sections, in combination with a fundamental basis.

That basis is formed by a horizontal plane, cutting the stratification on a level with the sea. Above that level we have undulating surface, with numerous fixed points upon it accurately defined, and already ascertained to be so many feet above the level of the sea, such as the several railway stations, rivers and bridges, towns and villages; and most important of all, as regards the subject under consideration, the various colleries at which pit shafts have been sunk to the coal seams which lie beneath. Below the horizontal plane basis, in the majority of cases, pit shafts have penetrated, and the record of each sinking not only indicates, or ought to indicate, the nature of the several strata cut through, but the depth, number, thickness, and quality of the different seams in which coal has been found, and may be considered workable or valuable now or hereafter. The inclination of the seams, direction and extent of working, situation, area, the tenure of the royalties, and general estimate of the working power, form items of information which, in the opinion of the writer, would be of the utmost value to all engaged in mining operations, and would, moreover, constitute a diagnosis of the coal field

in Northumberland and Durham worthy of the attention of this Institute.

The filling in such a plan as we have thus roughly sketched, must, it is obvious, be a work of considerable time, expense, and labour. It would have been satisfactory to the writer, if he could have embodied the whole of the information contemplated in this outline, before the members of the Institute at the present meeting; but, in consequence of the length of time required to read it, and the probability of its extending into another meeting to finish the facts properly, even if other engagements, and without assistance he should find himself unable to do so at the end of another month, having to go out of this country for a time, with that degree of completeness and accuracy which could alone render such a document valuable and important. It is his intention, however, to pursue the subject in fulfilment of the design now developed. In the meantime he submits the skeleton or frame work of the proposed structure.

The line of coast upon the sea level furnishes defined points at Redcar, Hartlepool, Seaham, Sunderland, Shields, Seaton Sluice, Blyth, Widdrington Castle, Newbiggin, and Amble. All of these are coal ports except Widdrington and Newbiggin, which are mere fishing stations.

Then inland, and running sufficiently parallel for the purpose required, the line of the York, Newcastle, and Berwick Railway, furnishes equally well defined points at Croft upon the Tees, Darlington, Ferryhill, Belmont, the Victoria Bridge over the Wear, Brockley Whins, Newcastle-upon-Tyne, Morpeth on the Wansbeck, and Warkworth on the Coquet. The distance of each of these stations as also many more in a direct line from the sea, as well as the height of each respectively above the sea level, or horizontal plane, selected as the sectional basis, having been determined and recorded, the bearing, distance, and elevation of various other points, including railways, public and private collieries, iron works, and all manufactories of importance throughout the entire range of the coal field may be added, and the whole accurately laid down upon a surface map, showing the undulation of hill and valley, the course of the rivers, and the line of outcropping coal seams and other strata.

A block section representing the surface and descending from it to a sufficient depth beneath, on sectional basis, might be made to represent the various strata; and sections of every pit might be shewn on plugs with the depth and thickness of each seam laid down to a scale and marked thereon, and circular holes drilled in their respective situations on the block to receive the plugs, so as they might be drawn out for inspection when required, to examine the strata of each district.

While upon this point, it may not be improper to direct the attention of the Institute to the great importance of its being rendered the special depository for such models and mining records, particularly of plans of sections drawn to a uniform scale of the underground operations of various collieries in the coal field, as far as they are known, or might be determined.

Mr. Sopwith, in his work on Isometrical Perspective, offers some suggestions with regard to such plans and the mode of constructing them; and the principle there laid down he has exemplified satisfactorily in practice, as applied to the Alston lead mines, the property of W. B. Beaumont, Esq., M.P. An arrangement might be adopted, at comparatively little cost, for filling up those plans from time to time, so that they would present a correct record of the progressive operations at any given period. Such a body of information as is here indicated with regard to sections and plans, would constitute a valuable treasury, not only for the present, but all future references.

In connection with or taking advantage of the government survey, taking the ordinance levels, and particularly their fixed marks at various points or angles over our coal fields, when those marks and the levels are given, and comparing them with our own, and when found correct, to be hereafter taken as fixed points to work from correct plans of underground operations, in all the mining districts, or particularly our coal fields throughout the kingdom would be of national importance, when we find that the produce is so large, viz., for England, Wales, and Scotland, 50 million tons, without even Ireland, besides the immense quantity of iron ore, also lead from different iron ore and lead mines.

CHAPTER XV.

PRICES OF COALS.

Whilst coal, which forms so important a branch of commerce, lies buried beneath the surface of the earth, at unattainable depths, it cannot be said to be of value. But no sooner does it come within the category of available materials in satisfying human wants than it assumes a position and a recognised price or exchangeable value in the market of merchantable commodities. That price being governed or regulated by various circumstances and conditions. Some of them within, but the greater number beyond the control of individuals or even of classes.

Eventually, however, these circumstances may be resolved into two, viz., supply and demand, but in every case the attainable price should sufficiently cover the cost of production, which includes royalty rent, interest of capital, wages of labour, outlay in materials, and expense of conducting the adventure, otherwise production would either cease altogether, or be carried on with loss to the producer. We have then four different classes of individuals, each having a separate and sometimes conflicting interest, which ultimately may be amalgamated in the price of coal, after various interchanges and fluctuations by the consumer, under which term may be comprehended all parties who either alter or destroy the characteristic features of the mineral by applying it to useful purposes.

The first step in production is to satisfy the original holders of the raw material. The machinery and other means necessary in order to carry on operations, or what is termed the plant, must then be provided. The actual workmen, agents, and superintendents are the next class of claimants.

These claims must be met, materials, machinery, buildings, horses, and workmen, stock provided, and all current expenses paid in the first instance out of capital, so that the capitalist enters the field and encounters the enterprise in its earliest stages. He is also the last to quit it, and the peculiar hardship of his case is that while he is the only one

engaged in the transaction that can be impoverished, the losses, if any, falling on him, he is the last to be enriched and may be the worst remunerated, as many adventurers, who did not understand it, have found to their cost, as far too many instances have proved, since Master Beaumont rode home, on his light horse, in the middle of the 17th century.

When the adventurer is himself landlord or lessor and capitalist, he of course combines the interest and responsibility of each. All these parties stand in relation to their own trade, as well as to every other in the position of consumers.

Much of the northern coal field is situated within the Bishopric of Durham, and a large proportion of it is held by the Bishop of that diocese, the Dean and Chapter and the Clergy, who do not possess any power of alienation, except in special cases conferred by act of parliament. Legislative arrangements have, however, been made, and are now pending, which are calculated materially to affect the position of the clergy in regard to mines.

The church lands in Durham and Northumberland are for the most part let on renewal leases. The freehold land in the county of Durham is of comparitively limited extent, but the contrary is the case in Northumberland.

The rents paid by the owners of collieries for royalties and way-leaves, including also outstroke and shaft rent, in the counties of Durham and Northumberland are estimated to be nearly half a million sterling per annum, over an extent of coal, comprising not more than 700 to 750 square miles. It may now be said that nearly the whole of the coal field of value has been taken up by private individuals or companies, and there is also a large portion where rent has been and continues to be paid without apparently any return being yielded for the outlay at present, or probably for several years to come, leaving a considerable but very precarious district yet unopened for adventurers.

The settlement of rents is of course a private arrangement between the respective parties, but it may be stated, that in consequence of the anxiety of great mining companies and influential proprietors to extend their royalties or procure additional ones, competition has been stimulated to an extraordinary degree, and very large sums paid by speculators in certain districts as premiums for leases, thus making the reserved rents much greater than they would have been.

Those dead rents necessarily for a time absorb a large proportion of the profit derivable from mining operations, and, in many instances, become redeemed.

The capitalist who undertakes to advance the money required to organise a colliery establishment, is not only entitled to interest, such as he might receive were his money advanced upon substantial security, but to such further additional sum as may cover the risk encountered. The adventurer may himself be the lessor, and furnish capital and superintend the whole of the business operations; in which case he would be entitled to additional remuneration. Even in prosperous cases, three times the amount of legal interest might not be so beneficial in the end as the deposit of the same amount of capital in the 3 per cent. consols, more particularly as the plant is of very little value after the exhaustion of the mine.

Clerks, agents, and others expect to be remunerated on a scale commensurate with that of similar classes in the other departments of trade, and according to the degree of trust and responsibility, which in addition to their other duties they are required to sustain. The labourers in our coal mines form what may be termed a separate class of individuals from the rest of the community. They reside for the most part in the neighbourhood of the mines wherein they are employed, in dwellings built or rented by the colliery owners, and have coals and gardens found them. These dwellings constitute, it may be said, a portion of the wages to which the workmen become entitled for labour performed according to agreement; and hence when their labour is suspended as in strikes, the owners have been led, after much ineffectual forbearance, to displace them (since the yearly hirings ceased, at their request) in order to provide accomodation for other workmen brought from a distance.

Now as the whole expense of material, labour, and interest of capital is to be paid out of the price obtained for the coal when wrought and brought to market, it is but natural that those who undertake the risk and responsibility of conducting all these operations should be anxious to get as high a price as possible. In some cases it has been customary for the coal owners to contract with fitters, at the port of shipment, to supply coals in certain quantities, at fixed prices, for a given period. In other cases colliery owners have freighted vessels, on their own account, to the London or other distant markets, and employed agents to sell on commission. Owners of ships have also been merchants of coal, bringing cargoes into the markets for sale, and on completion of the voyage the difference between the cost, including charges and selling price, being taken in payment of freight of ship and interest.

Before the market price for the coal sold is obtained, the coal has to be distributed through a multitude of channels, for multifarious indeed are

the intricacies of distribution before any portion of it reaches the actual consumer. In the meantime the hewer or working miner has to be sustained upon the wages paid to him by his employer. These wages are advanced, in the first instance, by the capitalist or adventurer, as part of the cost of bringing the coal into a marketable state, but it is evident that they must be finally discharged or repaid to the coal proprietor, by the purchaser or consumer, in the price for which it is sold. This, however, is not always the case, prices may fall so as to be unremunerative; and when this state of things prevail for any lengthened period, the coal owner has no other recourse than that of reducing the working expenses of his establishment, and immediate cash payments are often among the first to be curtailed. The consequence is a reduction of wages as the preferable alternative to suspending the works, either wholly or in part. Sometimes this reduction is quietly submitted to from the obvious necessity of the case, at other times it is resisted, but generally ineffectually, for it is seldom if ever proposed except in extreme emergency.

On the other hand a continuation of what may be considered comparitively high prices, very soon leads to a demand on the part of the workmen for an increase of wages. When such demand is deemed moderate and proper it is at once conceded, but generally such concessions are made with reluctance, and frequently to avert a still greater evil. The workmen on finding their demand resisted, deeming it just and reasonable, sometimes seek to obtain their object by passive means, and hence operations are suspended in what is termed a strike, a subject on which a good deal might be said from past occurrences, and which it was intended should form the next chapter in this memoir, but I now consider it might be out of place, and have accordingly omitted it.

CHAPTER XVI.

ESTIMATE OF COAL, RENTS, WORKING CHARGES, LEADING CHARGES, &c.

Memorandum of the average estimated cost of working and leading coal from collieries to the place of shipment, or to manufactories in the neighbourhood of the pits, while in the counties of Northumberland and Durham, the Tees or Cleveland, for the last twenty years, with an addition of interest, say at 7½ per cent., the capital embarked in the trade by the coal owners being £13,000,000, for the quantity of coals at present obtained is upwards of 13,000,000 of tons yearly in those two counties.

This amount expended is independent of the capital advanced by the public railroad companies within those counties, which have been the means of saving the coal owners a large amount which otherwise would have been required to be invested by them, say one half more of the above amount, making twenty millions sterling for the present quantity, or perhaps that would have given the advantage to the coal owners to increase the quantity to 20,000,000 tons yearly when required, or could be disposed of.

COALS DISPOSED OF SAY AS BELOW.

					£	s.	d.
6,000,000 tons	Rent at	0s. 6d. p. ton	£150,000				
Do.	Working charge	2s. 6d. ..	600,000				
Do.	Leading at	1s. 6d. ..	450,000				
Do.	Interest at	1s. 6d. ..	450,000				
		5s. 6d.			1,650,000	0	0

COAL FOR STEAM PURPOSES, &c.

3,500,000 tons	Rent at	0s. 6d. p. ton	£ 87,500				
Do.	Working charge	4s. 4d. ..	758,333				
Do.	Leading at	1s. 2d. ..	204,167				
Do.	Interest at	1s. 6d. ..	262,500				
		7s. 6d.			1,312,500	0	0

HOUSEHOLD COALS, &c.

3,500,000 tons	Rent at	0s. 6d. p. ton	£ 87,500				
	Working charge	5s. 4d. ..	933,333				
	Leading at	1s. 2d. ..	204,167				
	Interest at	1s. 6d. ..	262,500				
		8s. 6d.			1,487,500	0	0
				Total for cash ..	£4,450,000	0	0

Abstract of the annexed Amounts.

	Tons per Annum.	Rent.	Working.	Leading.	Incidentals or Interest.	£	s.	d.
		£	£	£	£			
For coke, gas, &c.,	6,000,000 ..	150,000	600,000	450,000	450,000			
Steam, &c., ...	3,500,500 ..	87,500	758,333	204,167	262,500			
Household, ...	3,500,500 ..	87,500	933,333	204,167	262,500			
	13,001,000 ..	325,000	2,291,666	858,334	975,000	4,450,000	0	0

In addition to the above, which includes a sufficient amount charged for the coals made into coke, there will be a further cost before the coke is shipped or disposed of, like the coals, out of those counties. In consequence of extra capital for 5,200 coke ovens in Durham, and 200 or 300 in Northumberland—

Of which cost £162,000 at 7½ per cent. per annum, equal		3d. per ton	12,150		
Produce of ovens 1,400,000 tons, manufactring.	1s. 3d.	..	87,500		
Loading to ship or carriage of the same out of the two counties. 1,400,000 tons loading	1s. 3d.	..	87,500		
				187,150	0 0
Estimated amount of yearly produce of coal and coke				£4,537,150	0 0

Independent of the above capital there is a further capital employed by railway companies in locomotive engines, and carriages for carrying the coke and coal. Therefore the produce of these two counties for coal might truly be said to amount to £5,000,000 sterling per year to pay for interest and risk to the coal owners of the Counties of Durham and Northumberland. Therefore it will be seen that this large amount yearly concentrated and coming into a district so circumscribed as 700 square miles, has been the cause of requiring an immense capital being expended in erecting manufactories in so suitable and cheap a coal district, thus assisting in carrying forward the same independently of the shipping and railroads which it must necessarily have employed.

CHAPTER XVII.

NUMBER OF COLLIERIES, PITS, AND WORK-PEOPLE EMPLOYED.

It may be now necessary to estimate and show the present amount of manual labour with the past (taken a few years ago,) and the progressive increase of the coal trade in the counties of Durham and Northumberland. We have the past, as to quantity, at various periods, from a pamphlet, entitled "Remarks on the State of the Coal Trade," 1843. It is therein stated that in the years

1773, there were only thirteen collieries on the Tyne; and in
1800, there were upwards of thirty; and in the year
1828, the number increased to forty-one on the Tyne, and eighteen on the Wear, making in all fifty-nine; and their working powers rated at 5,887,522 tons yearly.
1836, the aggregate capabilities of the district had sprung up from 5,941,812 in 1828 (including the Tees), to 9,623,922 tons, being an increase of 3,612,130, or fully 62½ per cent., and from 1836 to 1843 the increase was in a similar ratio.
From 1843 we have in 1853 or '54, an account stated of 13,333,331 per year. In 1829 the late Mr. Buddle reckoned the number of persons engaged in mines and in the above-ground operations connected therewith at the pits at 21,000. The return from the *Newcastle Journal of May 14th*, 1844, the result shown is:—

		Number of Collieries.	Number of Work People.
1844	Tyne	65	15,556
	Blyth	4	1,051
	Wear	31	13,172
	Tees	24	4,211
		124	33,990 of which 25,383 are below-ground.
			and 8,607 are above-ground.
			33,990 for 9,623,922 tons.

	In 1854, Number of Collieries.	No. of Working People.	Under Ground.	Above Ground.	Total.
Tyne ..	68	17,500	12,900	4,600	
Blyth ..	5	1,500	1,100	400	
Coquet	2	600	450	150	
Wear ..	21	8,050	6,200	1,750	
Hartlepool	22	8,450	6,600	1,950	
Tees ..	18	11,020	7,890	3,130	
	136 ..	47,120 ..	35,140	11,980	47,120 for 13,333,333 tons yearly.

As there has been no regular account taken of the number of work people employed in 1854, the foregoing may only be taken as an approximation.

To London from Durham and Northd. we have in 1853 say same 1854	3,217,060
The returns have not appeared, as yet, for the export or foreign in 1853, but may be stated at present that we are working at the rate of.....	4,000,000
And for home consumption, coasting, coking, and gas coal	6,116,273
Total	13,333,333 tons.

Therefore, as we have the foregoing statement as a data shewing at these periods every million of tons of coal raised in the two counties required workmen, after the rate of 2600 per million of tons for under-ground work, and 910 for above-ground: shewing the number in 1854 to be 47120, while working at the rate of 13,333,300 tons yearly; and further, shewing the increase over ten years to be 13,130, viz:—9,755 extra for under-ground, and 3,375 above, making 13,130 additional in the above time; and as there has been an alteration of late, in favour of the workmen, by increasing their prices in piece work and daily wages, and at the same time they doing a less quantity of work for the same amount of money as heretofore, therefore, we cannot reckon on any less number for each million of tons wrought, although great improvements are making daily to assist and cheapen manual labour.

Taking the present area of our Coal Field to cover 700 square miles in the two counties, the greater portion of the population (say nine-tenths) will be found employed in the coal works and the manufactories situated near the same, leaving only a small portion of the remainder for the lead and iron mines, and only a smaller portion still for the farming and landed interest. The population as taken a few years ago:—

In Durham	390,792
In Northumberland	305,508
	696,300

The greater portion are females, leaving about 345,000 males.

The number estimated as required to work in and about the pits is 47,120, viz:—under-ground 35,140, above-ground 11,989, for producing 13,333,333 tons yearly, the number of collieries being about 136, shewing each colliery to be working at the rate of 100,000 tons yearly, and, for the past ten years there are ten additional collieries, making an increase of one new colliery on an average yearly, with a further annual increase of 1,300 working-people, some collieries with more than three pits, many with two, and a large portion only one each, making 230 pits at work; and, for the aforesaid quantity, taking 270 working days as the yearly average, gives 222 tons each daily, although the power, as far as the

machinery goes, at all our best collieries, is now equal from 400 to 500 tons daily at each pit. Since "Guides" and "Cages" have been introduced into our collieries more work than what has been stated above has been done, for at South Hetton Colliery, where "shafts" or pits nearly 1,100 feet deep, designed under my care, and which were constructed with guides, one engine of 60-horse power produced 110 or 113 scores of coal daily, each score equal to six and a third tons, making 700 tons per day from the above depth, besides the men and boys, stone, materials, &c., for several weeks, so as to show the owners what might be done with one engine then at each of their pits, there being then two in work (and two so far sunk), with a 60-horse power engine each, which was the greatest quantity that had been produced at any one pit, either at this depth or any less depth, either before that time (1833) or since,* which, with the introduction of "edge rails" to tramways, superseded the old plates for the same purpose. Cages, with tubs containing coal, guided in shafts, also superseded the old use of wicker corfs, by being much safer and better, besides running them at greater speed with less risk in the shaft, but which, when first introduced, were thought to be of no practical utility, in consequence of the great depth of our north country collieries where the production of such a great quantity of work was required from each pit. However, by perseverance, both there and at Townley, where they fully answered, my then newly introduced system has been universally adopted, not only throughout the great Northern Coal Field, but, I also believe, the whole coal producing countries where pits are established. The advantages of this method, which has been already alluded to, and discussed in this society, and proved to have been a saving to the coal owners of Durham and Northumberland of upwards of £1,000,000 sterling annually, on their produced quantity of 13½ millions of tons of coal yearly in those two counties, which important trade is daily increasing with nearly all parts of the globe. Independent of the newly extensive wrought district of iron ore in Cleveland, and ore from other counties coming here, we have still others of very great importance in our own counties of Durham and Northumberland, both as to quantity and more particularly as to the quality of the ores, which will require an immense quantity of extra coal raised.

Great Britain alone, exclusive of Ireland, produces, from good authority,

* See Page 7 of T. Y. Hall's "Continuation of a Pamphlet on the Improvements in Colliery Workings, and Further Observations on his Safety Lamps, in December, 1853, in the Proceedings of the Society.

56½ millions of tons annually, on which large amount I intend to detail more particularly in Chapter XIX. It, therefore, would appear something curious, while we have such an increasing demand for coals, if an estimate was formed at the present period, of the probable time it would require to work out, or see what would remain in each royalty or district now under lease for the unexpired time in Durham and Northumberland, say 20, 30, or 40 years to come, showing what would then be left, and where, for the apparent heirs in each case.

CHAPTER XVIII.

FROM HOLME'S "TREATISE ON COAL MINES," DR. M'NAB, AND OTHERS, WE HAVE STATEMENTS AT DIFFERENT PERIODS, OF FORMER DATES.

An estimate of the number of persons receiving employment from this trade was made in 1792 by Dr. McNab, who calculated that 64,724 persons were employed by the collieries of the Tyne and Wear, of whom 26,250 belonged to the Wear, and 6,704 were pitmen and boys belonging to the River Tyne, and the remainder on the Tyne as follows:—

Fitters and Runners	103
Keelmen, Boys, Boatmen, &c.,	1,547
Trimmers, Ballast-heavers, &c.,	1,000
Pilots and Foymen	500
Seamen and Boys	8,000
Shipwrights, Keel Builders	946
Purveyors for Ships' Keels	1,100
Coal Factors, Clerks, &c.	2,000
And if one-fourth of these have families, and three in a family employed	16,425
Making a total at that time on the Tyne	38,325

In 1810, Mr. Bailey, in his "General View of the Agriculture of the County of Durham," estimated that there were thirty-four sea-sale collieries in the county, which annually vended 1,333,000 chaldrons of thirty-six bushels, and employed 7,011 men, and that the land-sale collieries in Durham vended 147,010 similar chaldrons, and employed 382 men. Mr. Bailey calculated that the proportion of coals carried to the Tyne from the Durham pits was as eight to five of those carried to the Wear. The keelmen on the Wear at that time amounted to 750; casters, trimmers, and fitters to 507; so that, by the above proposition, there would be 2,000 persons employed by the Durham trade on the Tyne; making the total amount, exclusive of pitmen, seamen,

&c., 3,257. The Newcastle coal trade is supposed to employ about 6,530 pitmen, and at this time the pitmen on both rivers may be fairly calculated at 10,000.*

Mr. Bailey calculates that the number of men employed in the aggregate, as casters, trimmers, keelmen, &c., is in the proportion of 10,650 to 1,480,080 thirty-six bushel chaldrons.

This is nearly the annual exportation of both rivers; so that in the working of pits and conveying of coals on board there is about 20,650 persons employed in this district, exclusive of landsale collieries.

The duties upon coal have been extremely variable; and with all the precaution possible, I run much danger, owing to the numerous acts, statutes, &c., relating to them, of making some incorrect statement; but this I have, of course, endeavoured to avoid, as much as circumstances will admit, by making brief references where I deemed longer ones unnecessary.

It will be unnecessary to trace the subject through its early gradations, suffice that on an average of six years, ending 1776, there were annually cleared at the Custom House of Newcastle, two hundred and sixty thousand chaldrons to London, ninety-two thousand to British ports and the Colonies, and twenty-seven thousand chaldrons to foreign ports.†

It appears by a treatise on the Coal Trade, published in the year 1789, by Mr. Beaumont, that France and her dependencies were in the habit of receiving upon an average twenty thousand chaldrons of coals annually from the Tyne and the Wear, principally for forging and distillery. This demand has however been subsequently decreased by the war, and it is not expected that it can revive to the former extent, as considerable improvements have in the meantime been made in the collieries of that country, and as coal is found more answerable to their purposes than any they could discover before, a circumstance which I fear will counteract Mr. Beaumont's anticipations that an increasing population would enhance the price of wood and other fuel, and thus augment her demand for coal upon this country. How different mattershavetaken place by increasing, as will be seen in concluding chapters.

* Now if such was the number at that date upon the quantities of tons of coals yearly above stated, the number of people depending upon the coal trade in this district must be very considerably increased on account of the vend being 13¼ millions yearly. The present number of brokers on Newcastle Quay and at other ports are considerably increased, this in connection with a new mode of transit, viz., public railways, without taking into account the extra number of people employed in manufactures in the Counties of Durham and Northumberland, to keep pace with the extra requirements of the coal trade.

† A chaldron is 53 cwt., nearly two and three-quarter tons.

CHAPTER XIX.

STATEMENT OF THE ANNUAL QUANTITY OF COAL RAISED FROM MINES IN GREAT BRITAIN, WITH NUMBER OF UNDER-GROUND WORKMEN.

As given me by one of our members, who is considered a particular careful writer on the subject of the Coal Trade, viz:—

	Tons Yearly.
For Household, about	19,000,000
Ironworks, about	13,000,000
Steam Gas Coking, and manufactures	9,000,000
Export over sea	4,000,000
Total, exclusive of Scotland and Ireland	45,000,000
As Scotland is found by Mr. William's, Inspector, to be about	7,500,000
Total, tons yearly	52,500,000

P.S.—Since I made out the above statement for Durham and Northumberland, I have been favoured with the results of what the Government Mine Inspectors make in each of their districts.

Uunder-ground.	Outport from Great Britain yearly—	
35,140 ..	From Northumberland and Durham	13,300,000
	Cumberland	1,000,000
31,950.....	Lancashire, and North Wales	10,600,000
28,000 (say)	Staffordshire, Shropshire, and Worcestershire	8,000,000
23,000 "	Yorkshire, Derbyshire, Nottinghamshire, Leicestershire, and Warwickshire	7,000,000
34,000 "	South Wales, Monmouthshire, Dean Forest, and Bristol Fields	10,000,000
21,250.....	Scotland	7,250,000
173,350	Total tons (exclusive of Ireland)	56,550,000
60,000 (say)	Besides mines for iron and other ores.	
233,650		

Mr. Williams, Inspector of Mines for Scotland, further states that 730 pits and 21,790 workpeople are employed for the above quantity in Scotland; and 9,300 workpeople for 3,000,000 tons of iron-stone ores, wrought in Scotland yearly. Mr. Dickinson gives us, January, 1854, 12 furnaces in North Wales; 5 in blast, at work, and 7 out of work. We have only 2 furnaces in Cumberland, but in South Wales, and Staffordshire, the iron works are very extensive, consuming large quantities of coal yearly, like those in Durham and Northumberland, as hereafter given.

CHAPTER XX.

COMPARISON OF COLLIERIES, PITS, AND UNDER-GROUND ESTABLISHMENTS IN DURHAM AND NORTHUMBERLAND, WITH OTHER PLACES.

Joseph Dickinson, Esq., Inspector of Coal Mines, states that the number of collieries in the districts of Lancashire, Cheshire, Anglesea, Flintshire, and Denbighshire, are 423, viz:—

LANCASHIRE.—Ashton-under-Lyne 7, Blackburn 21, Bolton 43, Burnley 14, Bury 11, Chorley 7, Leigh 15, Manchester 15, Oldham 28, Rainford 10, Rochdale, including Bacup and Rossendale, 84, St. Helen's 25, Wigan 54, making a total of	334
CHESHIRE	28
ANGLESEA	5
FLINTSHIRE	30
DENBIGSHIRE	26
Total collieries	423

The number of working pits or shafts, exclusive of those used solely for air, is	879
Besides additional winnings from day-hole levels	60
Total	939

From whence coals are raised at various depths. These pits have 849 steam engines at work pumping and winding, besides other engines used for surface arrangements, water wheels, with balances, hydraulic engines, horse gins, and horse runs also employed in a few instances.

The out-put of coals during the year 1852 reached nearly ten millions of tons, viz:—

679	pits with coals,	say from	44 levels	=723	out-put of coal in	Lancashire..	8,255,000
50	do.	do.	4	54	do.	Cheshire....	715,000
150	do.	do.	12	162	do.	North Wales	953,000
879			60	933	Total produce of the district		9,923,000

With the exception of about 1,000,000 tons, the whole of this large out-put appears to have been consumed in the district.

The exports for the year from Liverpool are stated at 105,952 tons coastwise, 277,645 tons foreign.

Shipments were also made from North Wales, Preston, &c., about 50,000 tons also were sent from Lancashire by rail, to London and the south.

The number of people employed in and about the collieries in 1852, amounted to 38,800, of whom 31,950 were employed under-ground, and 6,850 on the surface, making the total of 38,800, as follows:—

In Lancashire	25,540
In Cheshire	2,130
In North Wales	4,280
	31,950

The total number of 423 collieries produced, in 1852, 9,923,000 tons,

and employed, under-ground, 31,950 workmen, which is nearly 75½ work people to each; and each colliery produced 23,460 tons, as a yearly average. Taking the number of working days to be 270 annually, the working for each colliery would be about 87 tons. The number of pits being 939, gives 34 workmen on an average to each per day, for each colliery, making 39 tons per day in each pit, which gives a yearly produce of 10,568 tons, being 311 tons yearly to each under-ground workman, or $1\frac{15}{100}$ parts to each. To each collier there will have to be added an assistant, called a "putter," who trams the coal to the horse-way, or shaft foot, which reduces the stated quantity produced by the "hewer" in his day's work, and there are other under-ground workmen, as sinkers, pony drivers, road men, incline men, trap-door boys, off-hand men, waste men, deputies and over-lookers, all tending, with the limited number of working days, to reduce the produce of the "hewer" to what is stated above, although his real quantity on the average would be about four tons daily.

Mr. Dickinson in his "Statistics of Collieries," states that the total "out-put" of coals in Great Britain is not correctly known, but it may be stated at not less than 54,000,000 tons yearly.*

I find that in chapter XVII., page 94, that I have overrated the number of under-ground workmen in Durham and Northumberland for the quantity of 13,333,333 tons yearly. The number being stated as 35,140, which, in consequence of so large a quantity of the more tender coal being wrought for coke making the aforesaid numbers, may include the under-ground workmen for, say 17 collieries in Cumberland, or 2500 persons employed there, and making the produce 14,333,333 yearly from the 136 collieries, now 153, equal to 93,681 tons on an average, also 230 persons yearly for each colliery, but, taking the number of pits at 247 instead of 230 as stated heretofore, the produce will be for 143 persons in each, and 58,000 tons on the average yearly. That is taking 270 working days, which gives us 408 tons for each underground workman in Durham, Northumberland, and Cumberland, equal to a little more than 1½ tons per day, although a "hewer" might average in cutting coal, about 4 tons daily, yet it is reduced to what is above stated by the numerous other persons required under-ground to assist the production, which are independent of the persons employed on the surface at the pit's mouth and sundry other places about the colliery.

* I find that he has taken the produce of Durham and Northumberland at 11,000,000 instead of 13,333,333 as stated in the preceding pages, where it makes Great Britain produce, exclusive of Ireland, fifty-six and a half millions yearly.

TWO UNDER-GROUND ESTABLISHMENTS IN DURHAM.

	On Wear. Haswell Pit, as per T. J. Taylor, Esq., For 200,000 Tons Yearly.				On Tyne.—Townley Emma Pit, by Mr. R. Simpson, or the Writer for 100,000 Tons, Yearly.			
	Men	Boys	Men	Boys	Men	Boys	Men	Boys
1.—Staff (for safety) employed in superintendence, and in properly ventilating the mine and waste, in keeping roads, setting timber, removing obstructions, and doing all things necessary for the safety of the mine and the workmen:								
Overmen	2	—	—	—	2	—	—	—
Back overmen	2	—	—	—	1	—	—	—
Deputies	23	—	—	—	10	—	—	—
Inspectors	2	—	—	—	1	—	—	—
Wood-leaders	..	3	—	—	..	2	—	—
Trappers	..	7	—	—	..	4	—	—
Rolleyways	7	2	—	—	..	1	—	—
Furnace-men	2	—	—	—	1	1	—	—
Safety-lamp keepers	2	—	—	—	1	—	—	—
Shifters	12	—	—	—	2	—	—	—
Wastemen	8	1	—	—	1	—	—	—
			60	60			19	8
2.—Bargainmen, employed in stone-drifting, cutting through troubles, &c., generally by piece or bargain work (average)	..	..	12	12	..	..	4	—
3.—In transit of coal under-ground:—								
Putters	..	44	—	—	..	28	—	—
Couplers and loaders	..	12	—	—	..	2	—	—
Switch-keepers	..	10	—	—	..	1	—	—
Horse and pony-drivers	..	38	—	—	..	10	—	—
Inclines	..	12	—	—	..	2	—	—
Horse-keepers	2	2	—	—	1	—	—	—
Brakesmen underground	2	2	—	—	2	—	—	—
Firemen (engine)	..	2	—	—	..	—	—	—
Onsetters and greasers	3	4	—	—	2	2	—	—
			7	126			5	45
4.—Employed in cutting coal	210	..	210	—	98	..	98	—
Total	..	..	289	139	..	..	126	53

As above-ground requirements alter so much, according to circumstances, I have only taken under-ground working establishments at Haswell Pit in the Wear, and Emma Pit Townley Colliery in the Tyne, as my guide to make comparisons, the coal seams being different thicknesses, and the coal different hardnesses, in different places, which increase or diminish the hewing price. I, however, give the amount of manual labour required for two pits' underground staff, one with two coal drawing engines and 428 men and boys for 200,000 tons, the other with one coal drawing engine and 179 men and boys for 100,000 tons yearly; the latter even being the higher prices for hewing the coal, although being of a more tender and finer nature.

BLAST FURNACES IMPORTANT TO THE COAL TRADE.

	Furnaces out of Work.	Total out.	Furnaces at wrk in blst	Total in.	Total.
South Wales					
Staffordshire					
Scotland					
Mr. Dickinson gives the number of iron works in North Wales, viz:—	7		5		12
Those of most importance in Durham and Northumberland, for collieries supplying the same with fuel on the banks of the Tees, and as below, from a very circumscribed extent of our coal field, producing (independent of our large demands for coal and coke by railway transit to great distances,) also for sea-borne to London and Foreign, equal to about 8,000,000 tons of coal yearly, besides our local trade, which is increasing compared with those collieries in other districts, viz., Southern Counties and Scotland, which are working principally for manufacturing and local trade almost without London or coasting trade, and the following iron manufactories, increasing daily on the Tyne, Wear, Derwent, and Tees rivers, will require very large extra quantities of our coal to be wrought.					
NORTHUMBERLAND, viz.:—					
On the Tyne—Walker, Losh, Wilson, and Bell	1	....	4		
Do. Lemmington, Tyne Iron Company					
Do. Wylam, Bell, Brothers, and Co.	....	....	2		
Do. Bedlington, James Spence	1	....	1		
Do. J. Carr & Co., (erecting)	2	....	1		
North Tyne—Harishawe, Messrs. Woods & Parker, & Co.	4				
Do. Ridsdale, Mr. Forster	4				
The two latter have coal and ore on the spot of excellent quality, which will be connected shortly by a projected railway with the Newcastle and Carlisle Railway, near Hexham, this projected line will no doubt become a central independent railway to Scotland, laying between the York and Berwick, and Caledonian, and connect itself with the Great Northern at York, so as to become linked with all the railways in England, going through a maiden country, requiring a railway as an outlet to it.					
DURHAM:—					
On the Derwent—Consett Iron Company, near Shotley Bridge, manufacturing both pig metal, malleable bar and sheet iron, the same as is the case at Walker, by Losh, Wilson, and Bell, and the Tyne Iron Company.	1	....	12		
And also on the Wear—Towlaw, } Charles Attwood,					
Do. Do. Stanhope, Weardale, } Baring, Brothers.					
Do. Do. Witton Park, Bolckow & Vaughan	....	....	4		
Port Clarence, Durham—Bell, Brothers, & Company	1	....	2		
Darlington erecting (new ones) John Harris	2	....			
Birtley Iron Company	2	....	2		
H. L. Patterson & Co., Felling	2	....			
CLEVELAND:—					
Tees—Middlesbro' and Eston, Bolckow and Vaughan		....	9		
Eston—Joseph Pease	1	....	2		
Middlesbro'—Cockrance, Slade, & Co.	4	....			
Do. —Gilkes, Wilson, Leathum & Co.	1	....	3		
Do. —Mr. Samuelson	2	....			
	28		42		70

In Northumberland and Durham, including Middlesbro', there are 70 blast furnaces, in blast and building. Each furnace requires 600 tons of coals weekly for making 140 tons of pig iron, and for that portion of it which is converted into bars, rails, and sheets, which may be two-thirds of the whole quantity, the coals required will be 3 tons additional on 93 tons of pig iron, or say,

Pig iron.....	600 tons of coals
Bar rails or sheet iron	280 „
	880 tons of coals weekly.

Therefore, 52 × 880 = 45760 × 70 = 3,203,200 tons of coals required for 68 furnaces annually.

Each furnace, as above, will produce 140 tons of pig iron per week, therefore, 140 × 52 × 68 = 509,600 tons of pig iron yearly.

One-third is assumed to be sold to foundries as pig iron..	169,866
The other two-thirds are converted into bar, rail, or sheet iron.....	339,732
	509,598

N.B. Two-thirds of the above 339,732 tons pig metal will produce tons of rail or sheet iron.

Looking at the coke and gas trade, which is increasing daily, it may fairly be presumed that at this time, the consumption will not fall short of thirteen and a half millions annually, the increase being henceforth more rapid than heretofore in these two counties, and that notwitstanding, at present certain powers of production are limited. These, however, will soon be increased, and the production, ten or twelve years hence, cannot be assumed at less (provided they can be produced) than 20,000,000 tons annually. On this subject the reader is left to form his own opinions and conclusions, taking the datum we have previously given—say 14,000,000 tons yearly.

CHAPTER XXI.

WEIGHT OF COAL IN THE SOLID AND IN THE BROKEN STATE.

Coal, in its natural bed, pretty strongly indurated by time and a heavy superincumbent covering, weighs 78·12 lbs. per cubic foot. The same coal in the broken or wrought condition, as generally delivered into waggons on the pit bank, over screens, the width between the bars of which is $\frac{3}{8}$ of an inch, weighs about 47·87 lbs. per cubic foot; or, the solid to the broken coal, as 100 : 61·27. The small coal produced by such screening, passed over a $\frac{3}{16}$ of an inch screen, weighs about 43·08 lbs. per cubic foot, making the solid coal to the re-screened small, as 100 : 90, which represents this latter description of small coal as one-tenth lighter than the merchantable best coal. The trials which brought out the above figures were made chiefly on the Wear Hutton seam.

A seam of coal one inch thick contains, as it lies in the natural bed, 47·77 Newcastle chaldrons in an acre, being in weight 126 tons 12 cwt.

A seam one foot in thickness contains 573·26 Newcastle chaldrons, or, 1,519 tons 3 cwt. 0 qrs. 11 lbs. And a seam of one yard thick contains 1719·79 Newcastle chaldrons, or, 4,557 tons 9 cwt. 1 qr. 5 lbs. The weight of a cubic yard in the natural bed being 18·83 cwt.

A summary method of calculating the quantity of coal in an acre, in the counties of Northumberland and Durham is, to reduce the seam to cubic yards, and allow three of them to be a Newcastle chaldron. This is not quite correct, for if the computation be applied to a three feet seam, we have in an acre (4,840 yards÷8=) 1613·66 Newcastle chaldrons, which is 106·13 chaldrons less than the real quantity, or 6·17 per cent. below it. This, however, for practical purposes, is near enough, and makes the deviation on the proper side.

NOTE.—The 1613·66 is proved to be so nearly correct in the generality of coal seams, that I propose to take this as my standard in estimating the probable duration of the coal field in the Counties of Durham and Northumberland; and as regards coke, I find I have alluded in page 37 to the quantity that can be produced from good coking coal in a general way, by a process of testing in Dr. Richardson's (of Newcastle), la-

CHAPTER XXII.

COAL AND COKE.

So important an off-shoot of the coal trade has the business in coke become in these northern counties that it cannot be necessary to offer any excuse for devoting a little space to some observations relative to the connexion of coal and coke, and the comparative powers of the fuel in its twofold state.

The best coking coals of the Tyne are upon the western verge of the Basin—indeed, the same peculiarity seems to prevail throughout the coal field to its southern extremity. In the first portion, the Six-Quarter and the Brockwell seams, have yielded the Garesfield, Townley, and Wylam cokes; the first, being the property of the Marquis of Bute, and the latter of Mr. Blackett. These, exclusively, as regards the North of England, possessed both the home and the export markets for a long period of time; nor were they interfered with until within a few years back, when the demand for locomotive engines, as well as for abroad, became considerable. Other collieries, then, in the neighbourhood of those above adverted to, and some, more in the heart of the Basin, with coals not so well adapted, and many in Weardale (in the second of the above sections), with coal of excellent quality for the purpose, commenced coke burning, so that at the present time (May, 1847) the coke trade has risen up into one of considerable importance on the rivers Tyne, Wear, and Tees, with a flattering prospect for the future, as the demand, even now, cannot be met, and new sources of requirement are springing up in the shape of railways and foreign markets.

Deduced from results of very extended operations, I am able of my own knowledge to state that the Six-Quarter seam yielded 60 per cent.

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boratory, to be much more per centage than we generally get for saleable coke, produced from ovens of the present construction, when long burnt the average being only about 60 per cent., independent of a good deal of small as refuse going to waste, which, by and by, when saved, might be advantageously mixed up with the small coals that may be used by the manufacturers of patent fuel to be manufactured on an improved principle. I further find, in a treatise by B. Thompson, Esq., in pages 68 and 69, some very useful remarks on Coal and Coke, which I herewith give in detail, as I omitted the like in the proper place when treating on coke.

or something more, and the Brockwell about 53 per cent. A chaldron waggon of these cokes, of the Newcastle or statute measure, weighed and taken with care, was found to be 26 cwt. 2 qrs. 8 lbs., averaging 24 lbs. to the cubic foot. The commercial (or imperial) chaldron of coke (commonly, but erroneously, called 12 bolls) is a moiety of this, viz., 13 cwt. 1 qr. 4 lbs.

There are some rather singular coincident circumstances connected with coal and coke, which I shall new consider.

In the making of coke, when the combustion is over—that is, when the gases are consumed—the waste ceases, however long afterwards the charred fuel remains in the oven closed up and secured against the access of air; during which, however, a great improvement is going on in the hardening and perfecting of the coke. The time requisite for the *burning* part of the process, varies with the bulk of the mass under treatment as well as the nature of the coal itself. An oven charged (of course lightly) for a 24 hours carbonization (that is, charging, burning, and drawing inclusive) will have ceased its combustion in about 17 or 18 hours; charged for a 48 hours operation, with a good deal heavier load, the combustion will be done in 30 or 32 hours. These short periods may be said to be for private use—at least in this part of the kingdom—as, when coke is designed for sale, and particularly for shipment, regard to its appearance is expedient, and with this view much longer time for carbonizing is resorted to, as 72 and 96 hours, and occasionally even 120 hours, by which means a more compact, hard, and silvery-looking fuel is obtained. In South Wales, the furnace coals are less bituminous, contain more carbon, and are freer from sulphur. A shorter period for carbonizing is practised there than has been found requisite here, 24 hours for the complete operation being the most approved time. It is proper to observe, however, that by far the largest proportion of coke, used in the Welsh blast furnaces is made from large coal in open beds, such coke weighing from 31 to 32 lbs. the cubic foot.

In round numbers, it may be said that the coal yields half its weight and an equal bulk in coke—that the product (thus reduced in weight) possesses a heating power as great as the original fuel. These figures do not exactly represent the comparative capability and relations of the two conditions of the fuel; but, generally speaking, they sufficiently approximate for the present object. The quantum of heat thus wasted by the burning of the gases I am not prepared to state; but some idea may be formed of its importance when it is observed that a ton of good Newcastle coal by the coking process gives out from 10 to 12,000—say

11,000—cubic feet of carburetted hydrogen gas, about 10 gallons of tar, and about 18 gallons of ammoniacal liquor, all which products are absolutely destroyed. If the gas was valued, as for lighting purposes, at the low figure of 4s. per 1,000 cubic feet, it would amount to £2 4s. 0d., giving the tar and ammoniacal liquor in; while the coke produced by a ton of coal, assuming 60 per cent. to be the yield, would be 12 cwt., and the worth, at 10s. per ton, 6s., which is less than one-seventh of the value of the gaseous product now thrown away. What might be the value of the gas as a heating agent (as before remarked), I cannot definitely speak to; but I apprehend it will not be rating it too high to take it as equivalent to the coke. These facts are very striking and show a wide field spread out for the man of genius and science. For my own part I cannot doubt the arrival of the day (how soon or how late is not to be foretold) when the entire products of coal will be secured and rendered available.

Having had no inconsiderable experience in coke making, both in South Wales by open burning in beds, and by oven burning in this district, and having also experimented with ovens of (I apprehend) every variety of size and shape, it may not be deemed irrelevant, perhaps, if I offer some opinions which have resulted from the practice referred to.

The ovens in most common use here are of the circular kind, with dome tops. From this figure, I believe, I was the first to depart, by the adoption of the parallelogram form, being thereto induced by economical views solely for the quadrangular oven assuredly saves considerably in the cost of construction—1st, in the comparative expense of fire bricks; the one requiring bricks of a plain and ordinary size while the other must have them specially made both as to shape and size, which brings them to treble the cost; 2nd, a group of round ovens renders necessary a greater quantity of materials in the filling up of the angular vacuities; and 3rd, the workmanship is more expensive. I have found the saving to vary between a quarter and a third. Then, as to their comparative merits the idea may probably arise that as the circular oven comprehends a more concentrated body of the material the burning should be more uniform, but this does not appear to be the case. An impression is prevalent in this neighbourhood that the larger the body of coal employed and the better is the resulting quality of the coke. This is undoubtedly true; but it is a benefit gained at no trifling cost, which may be explained as follows. The larger the mass the longer the time required to burn off the gases; for while 17 or 18 hours are needed for the combustion of a charge adapted to a 24 hours' operation, double that time will be necessary for one of a 72 hours' process, and during the time

of combustion, not only are the gases burnt off but a quantity of carbon is also destroyed at the same time. Hence, the longer the time taken for burning the gases, the greater the waste of coke—a loss, on the whole, far from inconsiderable.

They find advantages in Wales by the shorter periods of carbonization, of a twofold nature, viz., the obtainment of a better yield, and the turning out of more work by the same means as to the number of ovens. The heat is kept up to a higher temperature by reason of these quickly repeated operations, and the short intervals of the burnings, which conduces greatly to the promotion of rapid and good results, both in respect of quantity and the per centage yield. By the extended operations, as carried on here, the heat of the oven is greatly reduced, even before the drawing commences; and, subsequently, the length of time necessary for the drawing, and again for the filling of so heavy a load as 9 or 10 tons (which not unfrequently happens), the temperature is, further, so very much lowered that the ignition of so large a body of coal is slow and the combustion very tardy; the light charges, on the contrary, going off at once, and that very vigorously.

It has often occurred to me that if an oven (suppose of 10 feet diameter) was charged for a 24 hours' process, with 2½ tons of small coal (which would form a layer of some 2 feet in thickness) was re-charged upon the coke as soon as the gases were consumed, viz., in 17 or 18 hours, with a fresh supply of coal some 18 or 20 inches thick (about 2 tons) that the high temperature of the oven, together with that of the coke itself, would be such as to complete the second burning, on Lord Dundonald's principle of distillation, stopping up all the openings for the ingress of air, and merely inserting a pipe for passing off the gases. By these means *all* waste of carbon would be prevented in the second proceeding, and a much greater yield of coke could not fail to be gained. In case the power of heat was found insufficient to carry out the distilling process, a little air, more or less as might be found necessary to aid the other means, could be admitted; but I am of opinion this would not be called for—a higher doorway might probably be required.

CHAPTER XXIII.

DURATION OF THE COAL FIELD.

[Which has been kindly communicated to me by Mr. G. C. GREENWELL, with leave to use it as I pleased. I give it as received, with the exception of a few short remarks.]

The subject of the present Chapter has frequently attracted attention, and very different results have been arrived at.

The following calculations probably assign to the Coal Field of Northumberland and Durham a shorter period of duration than many are prepared to accede to, but it is the writer's most decided opinion that, notwithstanding its shortness, its limit has been rather deferred than hastened. If, for instance, we take one of the largest class of royalties, and consider it to be worked in proportion to its extent, will not its endurance be a fair criterion of the duration of the whole? This is, of course, under the assumption of that state of things in which all royalties are at work; and it is tolerably evident, that unless coal be discovered beneath new districts (the new red sandstone suppose) the whole of the present known coal field will, in the course of a very few years, be in active operation.

The consideration of the present subject naturally divides itself into two parts.

1. The portion of the Coal Field already excavated.

2. The portion remaining unwrought, with the annual demand upon such portion.

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1. Probably the chief difficulty in presenting anything like an accurate estimate of the quantity of coal which may reasonably be supposed to be at one time or another workable to advantage, arises from the necessary vague and uncertain state of our information with regard to the quantity

of coal which has already been extracted, together with that which, in old workings, has been left in the mine in such a state as to be completely irrecoverable.

The following is an estimate of the quantity of coal which has been wrought from the Coal Field. The information on which it is based being collected from various publications concerning this neighbourhood :—

		CHALDRONS.
a. From the Rivers Tyne, Blyth, Wear, and Tees the quantity exported from 1843 to 1847, both inclusive, was (say)		13,366,390
b. The following is an account of the quantity of coals exported from the Rivers Tyne and Blyth previous to 1843 :—		
From 1836 to 1842 inclusive	7,697,880	
„ 1830 to 1835 „	4,800,000	
„ 1800 to 1829 „	20,223,273	
„ 1791 to 1799 „	4,625,827	
The vend from the Tyne in the year 1780 was 366,260 chaldrons, and in 1785, 449,997 chaldrons, and on referring back to 1710 the average of the previous four years was 178,143 chaldrons. The average export from these rivers from 1701 to 1790 inclusive, may be, therefore, taken at 280,000 chaldrons, which gives for this period a gross export of	25,200,000	
The quantity exported from the Tyne in 1613 appears, from a comparison with the duty paid to the town of 4d. per chaldron, to have amounted to 60,000 chaldrons ; therefore, assuming the average quantity during the 17th century to have amounted to 119,000 chaldrons, we have a gross quantity for that century of	11,900,000	
And suppose the vend from the Tyne, during the 400 years previous to have averaged 30,000 chaldrons per annum, we have for that period a total vend of.....	12,000,000	
The total quantity estimated to have been exported from Tyne and Blyth, previous to the year 1843	———	86,445,980

c. Quantity of coals exported from the River Wear previous to the year 1843 :—

From 1836 to 1842 inclusive	3,296,140	
„ 1829 to 1835 „	3,255,000	
„ 1816 to 1828 „	6,023,281	
„ 1748 to 1815 „	16,944,386	
The vend from the Wear in 1748 was 147,403 chaldrons, and in 1710, 65,760 chaldrons, the average from 1701 to 1747 inclusive may be taken at 110,000 chaldrons, which gives for this period a gross export of	5,170,000	
The export of the Wear during the 17th century may be taken at one-third that of the Tyne, viz.:	3,966,666	
And during the preceding 400 years, (say)	3,000,000	
The total quantity estimated to have been exported from the Wear previous to 1843	———	41,655,473

d. Quantity of coals exported from the River Tees, previous to the year 1843:—

From 1836 to 1842 inclusive	3,659,300	
From 1826 to 1835 „	574,260	
And suppose the whole quantity prior to 1826 to have been	150,000	
The total quantity estimated to have been exported from the Tees previous to 1843	———	4,383,560
Total quantity of coals estimated to have been exported from the Rivers Tyne, Blyth, Wear, and Tees, up to the end of the year 1847 (Newcastle chaldrons)		145,851,403
Home consumption, exclusive of coal consumed in manufactories, &c.:—		
The proportion of the population of Northumberland and Durham, supplied with coal from this coal field may probably be.....	450,000*	
And in Yorkshire, (say)	100,000	
	550,000	
Carried forward....		145,851,403

* At present, 700,000 and more.

Brought forward.... 145,851,403

And suppose 1-5th of this number to use round coal, and consume one chaldron per annum each, the annual quantity thus consumed will be 110,000

And supposing the consumption to have increased in the same degree as the exportation, this would give a total quantity of round coals consumed, equal to 6,000,000

Total quantity of round coals† exported and consumed, landsale, from the coal field of Northumberland & Durham 151,851,403

For every chaldron of the above, at least half a chaldron of small and refuse coals has been produced from the gross quantity drawn to the surface out of the mine, since the year 1780, when the practice of screening was introduced; from this source 4-5ths of the home consumption and the manufactories being supplied; the remainder, in general from 12 to 16 per cent., being wasted. Owing, however, to the less skilful mode of extraction adopted formerly, we may suppose that the loss was equalled in former years, much coal having been left underground in pillars now totally irrecoverable. To the above quantity therefore add one half, viz.:— 75,925,701

Also, loss underground; barriers against adjoining royalties to prevent influxes of water; or other casualties occasioned by forming communications with old workings, drowned up or filled with inflammable or other noxious gas; also bad coal adjoining dykes and slips; and a certain amount of loss in pillar working under the present system, at least equalled by losses of other descriptions from thrusts or creeps under former management, previous to the extraction of the pillars, say 1-4th of the whole quantity, or one third of the above 75,925,701

Total estimated quantity of coal excavated from, or lost underground, in the coal field of Northumberland and Durham 303,702,805

† This is, strictly speaking, scarcely correct, for, on the one hand, the home consumption would, in former years, bear a greater ratio to the present consumption than the former to the present export (for many and very obvious reasons), which must raise the gross home consumption higher than the quantity put down, while on the other hand there is a certain quantity of small coal contained in the gross export, which ought properly to have been deducted; the whole, however, is but at best an approximation, which would not be materially affected by the correction of the above errors, one of which, indeed, may balance the other.

2. We are now brought to the consideration of the second division of this chapter, which consists in the attempt to calculate the quantity of coal remaining in the coal field in an accessible and workable state; this we shall effect by deducting the quantity of coal estimated above to have been exhausted or rendered valueless, from the quantity supposed to have been contained in the coal field in its original and unbroken condition.

Instead of assuming, as has generally been done, the gross area of coal field and the average thickness of workable coal therein contained, it is preferred, in the present instance, to estimate the workable area of each seam in order, as by so proceeding, a little more accuracy of result may reasonably be expected to be attained. At the same time it must be admitted that whatever such result may be, it must be viewed in a very qualified light, as certainly being, to say the least, but an approximation.

We shall, therefore, take each seam in order, commencing with

1. The High Main Seam.—The boundary of workable High Main may be said to extend as follows: from North Shields to Earsdon and Hartley, thence a little to the North of Burradon, North of Wide Open and Fawdon, West of Kenton, and across the west part of Newcastle Town Moor to Newcastle, from Newcastle to Benwell, and across the Tyne to Gateshead, thence to Gateshead Fell, South of Heworth and Hebburn, then returning to North Shields. The above comprises an extent of fifty one square miles of coal, the average thickness of which may be taken at 5½ feet, and calculating three cubic yards of solid coal to weigh one chaldron, the gross quantity of coal contained in the High Main Seam will be equal to 96,549,120 Newcastle chaldrons.

2. The Five-Quarter Seam.—The boundaries of this seam in its workable state are more difficult of definition. It may be stated to exist in a fairly workable state, as regards thickness and quality, under the following districts.

	SQ. MS.
a. East of the River Wear from Newbottle to Pittington, 4 miles by 1½ miles	6
b. From Pittington, South-east by Haswell, Easington, and Castle Eden, then West by Wingate Grange, Trimdon, Cornforth, Chilton, Eldon, Shildon, and Coppy Crooks, thence North by St. Andrew's Auckland, and Bishop Auckland, to the Butterknowle	
Carried forward.....	6

Brought forward.... 6

Dyke; from this point the slip is the north boundary of both Five-Quarter and Main Coal Seams as far east as Ferryhill, then North-east to Coxhoe, Quarrington, Cassop Moor, and by Sherburn to Pittington. The extent comprised within the above boundary is altogether equal to 44

c. In the Pontop and Beamish district there is a considerable tract of Five-Quarter Seam, probably an extent equal to six miles by four, or 24

Square miles 74

The average thickness is three feet six inches, exclusive of splint, which is so generally left underground that it is not considered worthy of a place in this estimate. The gross quantity of coal contained in seventy four square miles of a coal seam, the thickness of which is three feet six inches, is 89,142,028 chaldrons.

3. The Main Coal Seam—(Yard Seam of the Tyne)—is more extensively distributed, the following being its boundary:—

SQ. MLS.

a. The Main Coal. From Washington, East of Pensher, Ryhope, Seaham, Dalton-le-Dale, South Hetton, Elemore, and thence North to Washington: this district contains 32

b. Add also the districts containing the Five-Quarter, as above 74

Square miles 106

SQ. MLS.

c. The Yard coal, workable throughout the district north of the Ninety-fathom Dyke, to the extent of six miles by three 18

The gross quantity contained in the Main Coal or Yard Coal will therefore be:—

NEWCASTLE CHALDRONS.

106 square miles, 4½ feet high 164,173,754

18 square miles, 3 feet high 18,585,594

Total 182,759,348

4. The Bensham or Maudlin Seam.—Also Low Main Seam of Wear Collieries and Hutton Seam of the Pontop district.

The boundary of the Bensham in a workable state is from North Shields to Sunderland on the East, from Sunderland to Pensher on the

South, and thence across the country to Wallsend, and East to Shields; contents forty-five square miles.

The Low Main exists under a large portion of the coal field in the County of Durham, in fact, with the exception of the district from Gateshead to the South-west, under almost the whole. The area of Low Main or Pontop Hutton Seam may probably be two hundred square miles, of which, however, the thickness is exceedingly variable, being found in large tracts of little more than the thickness considered barely workable. The gross quantity contained in the Bensham, Low Main, or Pontop Hutton Seam may therefore be equal to:—

	NEWCASTLE CHALDRONS.
45 square miles, 5 feet high	77,439,912
200 square miles, say on an average three feet high	206,506,600
Total	283,946,515

5. The Hutton Seam of the Wear or Tyne Low Main.—This seam exists in a workable state throughout a great part of the coal field: its boundary may be thus defined:—

The east coast from Warkworth to Castle Eden, thence to Thornley, and west along the Hett Dyke to the Stockton and Durham Turnpike, then north-west to Heugh Hall and west of Durham to Plawsworth, thence to Lanchester, and from Lanchester by an irregular line to Warkworth. The extent thus inclosed is equal to 350 square miles of coal, 4½ feet thick, neglecting the coarse coal at the bottom, which is chiefly left in the mine, and the quantity of coal contained therein is equal to 542,083,150 chaldrons.

6. The Beaumont or Harvey Seam—Has not been discovered in a good state below Newcastle Bridge, and cannot perhaps be calculated on existing over a greater extent of country than the following, some of this even being doubtful, from Newcastle to Sheriff Hill, direct south to Durham and thence to Coxhoe, from Coxhoe west to Evenwood, north to Wallbottle and back to Newcastle, comprising an area of .. 120

Also a tract from West Auckland to the east sea, of an average breadth of 3 miles..... 60

Square miles.. 180

And the average thickness being taken at 3 feet 6 inches, the quantity of coal contained in the above area of 180 square miles is equal to 216,831,940 Newcastle chaldrons.

The extent of the next seams is very uncertain, as the localities where they may be chiefly expected to be met with have not been much explored; none of them have been yet discovered east of the turnpike road from Newcastle to Bishop Auckland.

7. The Stone Coal—In the neighbourhood of Ryton may perhaps exist under an area of 20 miles, in a barely workable state, 2½ feet thick. The quantity of coal contained in the seam will therefore be 17,208,880 chaldrons.

8. The Lower Five-Quarter Seam.—Say under an area of 40 square miles, 3 feet thick, will contain 30,975,990 Newcastle chaldrons.

9. The Three-Quarter Seam.—May exist under an extent of 20 square miles, 3½ feet thick, and contain 24,092,440 chaldrons.

10. The Brockwell Seam.—The extent of this seam is very doubtful; it may, at a hazard, be said to exist beneath the whole of the district west of the Newcastle and London Road, between Newcastle and Rushyford, a distance of 24 miles, to the western boundary of the Coal field; this would give an area of 250 square miles, the coal averaging 4½ feet in thickness, the quantity of coal will therefore be 387,202,250.*

The gross quantity of Coal estimated to be the produce of the seams of coal found in the Coal field is then as follows:—

		Newcastle Chaldrons.
1.	High Main	96,549,120
2.	Five-quarter Seam	89,142,058
3.	Main Coal	182,759,848
4.	Bensham Seam	283,946,515
5.	Hutton Seam	542,083,150
6.	Beaumont Seam	216,831,940
7.	Stone Coal	17,208,880
8.	Lower Five-quarter	30,975,990
9.	Three-quarter Seam	24,092,440
10.	Brockwell Seam	387,202,250
	Total quantity exclusive of what may be worked beneath the sea	1,870,791,661

* If, however, the Auckland Bitchburn seam correspond with the Busty Bank seam instead of the Brockwell, the quantity of coal contained in the Brockwell will be diminished, and that in the Stone Coal and Lower Five-quarter increased in the same proportion, the aggregate continuing the same.

Brought forward....	1,870,791,661
And supposing that an average breadth of two miles may be worked under the sea, for the whole length of the Coal Field, and granting that two good seams of coal may be accessible, we have 100 square miles of coal, 9 feet thick, which will produce	309,759,900
Gross Chaldrons....	2,180,551,561
From this must be deducted the quantity estimated to to have been already extracted.....	303,702,805
Quantity of coal now remaining in the mine	1,876,848,756
From the gross quantity must be deducted loss underground, which by further improvements in the method of working coal we hope to see much further reduced, but say one-sixth.....	312,808,126
Quantity of coal to be drawn to the surface	1,564,040,630
It may also be reasonably expected, that coals will ere long cease to be so heavily screened as they are at present, and that merely a sufficient quantity of small coal will be extracted to supply the consumption about collieries, and such as a constant home demand for small coals for manufacturing purposes will always require. For these purposes probably one-fifth of the gross drawings will suffice (say).....	312,808,126
Total quantity of merchantable round coals estimated to remain in the coal field of Durham and Northumberland in an accessible state.	1,251,232,504

If the annual demand should be equal to 10,000,000 tons or 3,773,585 Newcastle chaldrons of round coal, a quantity which it is exceedingly probable will within a few years be realized, the above will be exhausted in 331 years. Should the demand exceed this, (a circumstance considered worthy of notice by a good authority in the coal trade*), the duration of the Coal Field will of course be proportionably less.

In the above calculations no notice whatever is taken of the thinner

* Observations addressed to the Coal Owners of Northumberland and Durham, by T. John Taylor, Esq., 1846.

seams which have occasionally been estimated at great prospective value, because unless their quality is of a very first-rate and peculiar description they will never be worked except for home use, as when compared with coal from other districts their cost of extraction will be found to be too great.

It must be obvious, that if it be really the case that the duration of our coal field is limited to the extent above calculated, every means should be adopted whereby our resources should be husbanded to their utmost, so that of a non-productive article, such as coal, none should be suffered to go to waste.

The existing mines will beyond doubt require, at no very far distant period, to be worked to their fullest extent to supply the demand which is now increasing at so rapid a rate; and since the gross quantity of coal left in the coal field is by no means equally distributed, it must necessarily follow that long prior to the limit assigned, by the present method of manufacturing round coals, many mines by working an unnecessarily large quantity must, even before their legitimate time, have ceased working altogether.

It should, therefore, be an object to all deriving their supply of coal from this district, with even no other view than the postponing of future monopoly, to insist upon as great as possible a produce of a description of coal less heavily skreened than the round coals manufactured at present; but which would reach the consumer in a state equally free from dead small, and be no doubt as intrinsically valuable. To screen the coal less heavily should also be the best policy of the coal owners themselves, especially those having limited tracts of valuable descriptions of coal.

I am aware that anything like a restriction will be viewed with great distrust, and that it is liable to many objections. In truth the matter is not very easily disposed of, for if the landlord of the mine and the owner of the wrought coal both agree upon the subject of the waste in question, whose province does it become to interfere?

At the same time, though all *waste* should be as much as possible provided against, there are no reasonable grounds for restriction of sales of any description, even were it the fact, that the duration of the coal field were limited to half the extent estimated. For the only result of the complete exhaustion of the coal field of this district would be the removal of the seat of certain manufactures from this to another locality, the country at large being totally unaffected; and, further, regard being had solely to the advantage of this neighbourhood, if it be admitted that the

greater the trade the greater the prosperity, it must be evident that the free use of our resources must be most beneficial, for the present worth of even one flourishing century is far more than that of a thousand years where trade is harassed by restriction, and checked by the exercise of groundless fears.

CORRECTED STATEMENT OF PAGE 104 OF BLAST FURNACES IMPORTANT TO THE COAL TRADE.

	Furnaces out of Work.	Furnaces at wrk in blst
Those of most importance in Durham and Northumberland, for collieries supplying the same with fuel on the banks of the Tees, and as below, from a very circumscribed extent of our coal field, producing (independent of our large demands for coal and coke by railway transit to great distances,) also for sea-borne to London and Foreign equal to about 8,000,000 tons of coal yearly, besides our local trade, which is increasing compared with those collieries in other districts, viz., Southern Counties and Scotland, which are working principally for manufacturing and local trade almost without London or coasting trade, and the following iron manufactories, increasing daily on the Tyne, Wear, Derwent, and Tees rivers, will require very large extra quantities of our coal to be wrought.		
NORTHUMBERLAND.		
On the Tyne—Walker, Losh, Wilson, and Bell	1	4
Do. Lemington, Tyne Iron Company	....	2
Do. Wylam, Bell, Brothers, and Co.	....	1
Do. Bedlington, James Spence	....	2
Do. J. Carr and Co.,	....	2
North Tyne—Harishawe, Messrs. Woods and Parker, and Co.	4	
Do. Ridsdale, Mr. Forster	4	
The two latter have coal and ore on the spot of excellent quality, which will be connected shortly by a projected railway with the Newcastle and Carlisle Railway, near Hexham, this projected line will no doubt become a central independent railway to Scotland, lying between the York and Berwick, and Caledonian, and connect itself with the Great Northern at York, so as to become linked with all the railways in England, going through a maiden country, requiring a railway as an outlet to it.		
DURHAM.		
On the Derwent—Consett Iron Company, near Shotley Bridge, manufacturing both pig metal, malleable bar and sheet iron, (the same as is the case at Walker, by Losh, Wilson, and Bell, and the Tyne Iron Company)	1	12
And also on the Wear—Towlaw,—Charles Attwood and Company	1	4
Do. Do. Stanhope, Weardale,— Do. Do.	1	
Do. Do. Witton Park, Bolckow & Vaughan	....	4
Port Clarence, Durham—Bell, Brothers, and Company	1	2
Darlington erecting (new ones) John Harris	2	
Birtley Iron Company	0	2
H. L. Pattinson and Co., Felling 2, and Washington 1 =	....	3
CLEVELAND.		
Tees—Middlesbro' and Eston, Bolckow and Vaughan	....	9
Eston—Joseph Pease	1	2
Middlesbro'—Cockrance, Slade, and Co.	4	
Do. —Gilkes, Wilson, Leathum and Co.	1	3
Do. —Mr. Samuelson	2	
Say 70 when working regularly, may use nearly three and a quarter million tons of coals yearly.	23	52
Total		75

THE AUTHOR'S REMARKS ON MR. GREENWELL AND OTHER WRITERS ON THE DURATION OF THE NORTHERN COAL FIELD.

Mr. Greenwell takes the width of coal obtainable along the coast, under the sea, at two miles; I, however, prefer, taking only half that width, giving an area of fifty square miles, and I would select only that portion where the seams are in the greatest perfection, and very deep under the sea.

I shall only make a few remarks upon the probable duration of the coal fields, as estimated by Mr. G. C. Greenwell. In 1846, with a yearly consumption of 10 millions of tons of round coals, Mr. Greenwell fixed the period of 331 years as the time in which the whole area of the coal would be worked out. In this calculation 100 square miles of coal beneath the sea is included. But the yearly sales having now increased to thirteen and a quarter millions, a proportionate alteration must be made in the period of duration; therefore, assuming the correctness of the previous statement, 324 years may be taken as the full extent of the time the coal field will last. I may further add, that various methods of calculation, by sections of different districts, have been tried both by Mr. Greenwell and myself, unknown to each other, and the results, which it was impossible to anticipate, have been found to be perfectly similar.

I intended to have shown that the information given by Mr. Hugh Taylor and other writers does not differ much from mine, either as to the extent of area, or the thickness of the coal seams; but, having got Mr. G. C. Greenwell's opinion, I prefer giving it. Although many districts have been proved since 1829 or 1846, there are still many seams found of workable thickness, which have not proved profitable to work at present prices. One most important fact is clearly demonstrated, viz:—that nearly treble the quantity of coal is wrought since Mr. Hugh Taylor's opinion was made public, and increased demand or the opposite, will render all statements on this point liable to error.

It may be necessary to remark that Mr. Greenwell's statistics were made in 1846, at which period he assumed 1-5th of the whole extracted to be small coal. At that time, and formerly, the great bulk of the small coal was consumed by fiery pit heaps, and stored away underground as waste. On account of the great demand for coal at present, and the enhanced value of labour, the 1-5th that he calculated as small, independent of the ten millions of round, has become in demand as saleable coal; I therefore consider Mr. Greenwell's estimate of the duration of the coal field equally as probable as my own.

It will be unnecessary to increase the length of this treatise by alluding to the statements of Mr. R. C. Taylor, of America, who has written on the subject. This will be admitted when it is known that, although the information given in his valuable work is generally correct, he had never visited or made himself personally acquainted with our coal districts and various coal seams, when he estimated the duration of the coal field at upwards of 1,700 years.

CHAPTER XXIV.

MY ESTIMATE OF THE DURATION OF THE COAL FIELD IN NORTHUMBERLAND AND DURHAM.

According to statement in Chapter XII, and the plan annexed, the coal field under 750 square miles, which includes 50 square miles under the sea, has been divided into several sections, taken at many different points so as to ascertain the average thickness of the seams in each district of square miles. The author gives the following as the total number of tons which he considers may be worked out of each. Taking the figures as here stated, and dividing the same by the present annual amount obtained, the number of years which it will take to exhaust the existing coal field is shewn.

The following is the tabular statement:—

No.		Square Miles.		Total Tons in each Section.
1	Wear	68·16	.....	1,086,151,660
2	Tees } Best W.E. Household Coal	11·53	.....	162,776,520
3	Tyne	13 "	.....	259,048,800
4	Seaham & Ryhope (Under the sea,) ..... 18 "	47·31	Best Household	379,074,168
	Five-quarter Seam, &c., south of the Hett Dyke ..... 21 "			
	Sundries at different places .. 8·31			
5	.....	51·65	.....	706,778,600
6	Steam Coal on the Tyne.....	23·25	.....	318,153,000
7	.....	21·18	.....	260,844,408
	Say under the sea at Hartley, Blyth, and Wansbeck	21 "	.....	140,000,000
8	Coking Coal—Tyne, Derwent, and Wear Western District	84·67	.....	695,174,568
9		62·55	.....	1,198,307,880
10		21·50	.....	196,137,333
11	Sundry Sorts	21 " / 21 " / 34 "	.....	649,758,400
12	Do.	12 "	.....	120,419,200
13	Do.	9·75	.....	71,156,813 $\frac{32}{100}$
14	Do.	155·25	.....	1,487,108,700
15	Do.	14·46	.....	198,370,640
16	Do.	28·90	.....	263·545,066 $\frac{66}{100}$
17	Sundries of little account	28 "		
	Quantities 140, 117, 169, and 324 = 750 square miles.			8,182,805,757
	The deductions that have to be made from the above are:—			
	First, one-fifth of the whole, which being required for pillars, barriers, &c., must remain or be lost....		1,608,561,151	
	Second, the quantity already excavated		898,812,433	2,507,373,584
				5,575,432,173
	But having regard to the difficulties of obtaining coal in certain localities, from the workings filling with water, and the large quantity of coal which will be irrecoverable, from that and various other causes, a further reduction in the period must be made, estimated at one-tenth of the remainder			553,543,217
				5,121,888,956
	Which, divided by fourteen millions annually excavated for sales and pit consumption, gives			365 years.
	But supposing the demand to increase to 20 millions annually in a few years, already referred to as being probable, and that quantity can be annually excavated, the duration of the coal field in such case would be only.....			256 years.

CHAPTER XXV.

CONCLUDING OBSERVATIONS.

Mr. Clegg, in his work on Coal Gas, has shown so comprehensive and generally correct view of the Coal Fields of the world, that it is worthy of extracting in an abridged form, and also of being corrected in one or two particulars, with respect to which the author has fallen a little into error.

He remarks that Great Britain takes the first rank, both in quantity and the quality of its coal, yet he greatly understates the annual produce of the island, which is (exclusive of Ireland) over 58,000,000 tons, not 32,000,000. A correction that equally applies to other authors, who have made estimates on the Northern Coal Field.

America, the yield of which he gives at nearly 3,000,000 tons of anthracite and 2,000,000 tons of bituminous coal, produces fully 20 per cent. over these quantities. There is ground to believe, however, that his statements of the produce of different countries of continental Europe may be more implicitly relied on. He says Belgium produces annually 5,000,000 tons; France 4,200,000 tons; Prussia 3,500,000 tons; and Austria about 1,000,000 tons; and there is every prospect that in consequence of the construction of railways the production will largely increase; the population not only requires it, but it will be necessary for their manufacturing purposes, which indeed, at the present time are increasing rapidly, and prices are 30 per cent. higher than for years past.

Belgium is a coal producing country, second to Great Britain, traversed by a large zone of bituminous coal, and may be described under three divisions. The Western or Hainault division, Charleroi or Liege district, and that of Namur. The area of those fields are about as follows.:—

1. In the province of Hainault.....	187,116	English acres.
2. In that of Charleroi or Liege	103,151	Do.
3. In that of Namur.....	41,125	Do.

Being 1·22nd part of the superfices of Belgium. The eastern or Liege division, from the province of Namur, traverses that of Liege, extending

towards Rhenish Prussia, where it communicates with other coal basins. It furnishes some coal of excellent quality. The whole being chiefly consumed in the many iron works of the district. In the Hainault most varieties of coal are met with, including the flaming, with a series of veins approaching to that of Newcastle-upon-Tyne, and adapted to gas making.

The production of France has advanced from 240,000 tons at the commencement of the First Revolution, to 4,200,000 tons (the quantity yielded at present). Notwithstanding this advance of 1,700 per cent. upon her native production, her importations have also increased during the same period 792 per cent., the quantity of coal imported being still more than one-half of the entire amount produced at home. The general quality of the French coal is not to be compared with that of Northumberland and Durham, Yorkshire, Lancashire, Derby, Staffordshire, Wales, &c., or Ireland, from the mines of which both the French Government and private companies obtain the best coal they use. Even America still continues to require large supplies from England.

Mining and manufacturing enterprise both suffer from the scarcity and dearness of coal and wood in France, although change in their national habits, and the facilities afforded by railways will increase the produce and lower the prices. The distance which their coal fields lie apart render it unlikely that the price of coal will ever become so low as it is in England, in consequence of the great expense of its inland transit to shipping ports.

America yields bituminous coal in abundance and from her energetic advances in everything relating to trade will, doubtless, ere long, stand second as a coal producing country, and will also make rapid progress in gas-lighting. The railways will easily, cheaply, and yet profitably for themselves, connect the towns with the distant anthracite districts, and it is even possible that Canada may be supplied more certainly and economically than with sea-borne coal. Wood fuel being almost entirely used for railway locomotives and steam-boat engines, (alike in the distant villages and cities,) and particularly on board the boats on the Ohio and Mississippi. I have seen them, when the boats are racing against the stream put in flitches of fat bacon, which can be had for two or three cents a pound, to assist the wooden fuel, raising the steam up to 150 and 200lbs. per square inch.

In the United States, hitherto, no anthracite coal, and only a small district of bituminous, has been found near to a shipping port or place with tidal water. This small portion is on the James River, Chesterfield County,

near Richmond, Virginia, and is called the Black Heath, Mid-Lothian, and Clover hill pit district. The produce is easy of transit, being only ten to fifteen miles by public and private railway, or about the same distance if by canal, to the shipping place above Norfolk, on the James River. A considerable portion of the State of Virginia, and also the remainder of the coal districts of the States, twelve of which are not so favourably situated, are from 150 to 300 miles and upwards distant from tidal water and the place of shipment or principal depôt for sale.

The following table exhibits the vast area of her coal fields according to S. A. Mitchell, who published them in 1836.

		Area of States. Square Miles.	Coal Area. Square Miles.	Proportion of Coal.	
1.	Virginia ..	64,000 ..	21,125 ..	1.3rd	Bituminous coal
2	Illinois	59,130 ..	44,000 ..	3·4th	.. ..
3.	Pennsylvania	43,960 ..	15,437 ..	1·3rd	Bitum. and anth.
4.	Kentucky ..	39,015 ..	13,500 ..	1·3rd	Bituminous coal.
5.	Ohio	38,150 ..	11,900 ..	1·3rd	.. ..
6.	Indiana	34,800 ..	7,700 ..	1·5th	.. ..
7.	Missouri....	60,384 ..	6,000 ..	1·10th	.. ..
8.	Michigan ..	60,520 ..	5,000 ..	1·20th	.. ..
9.	Tennessee ..	44,720 ..	4,300 ..	1·10th	.. ..
10.	Alabama ..	50,875 ..	3,400 ..	1·14th	.. ..
11.	No. Carolina	45,000 ..	200 ..	....	.. ..
12,	Georgia	58,200 ..	150 ..	1·38th	.. ..
13.	Maryland ..	10,829 ..	550 ..	1·20th	.. ..
		610,283	133,332	Nearly 1·4th	of Twelve States.

Cannel coal of good quality is found in Pennsylvania, Kentucky, Ohio, Illinois, Missouri, Indiana, and it is believed in Tennessee.

Even making certain deductions, the actual yielding area is enormous, and of its ultimate value no present estimate can be formed, but, if we consider that the American Coal Trade commenced in 1820, with 365 tons, and that its present production is 6,000,000 tons, we must feel certain that its influence will be felt at no distant period.

Canada, it is pretty clearly ascertained, contains no workable seams of coal, but in other provinces of British America, viz:—New Brunswick and Nova Scotia, there are considerable fields of it, and Newfoundland is said to be rich in this mineral. In Cuba no coal is found, but in fissures a quality of limestone, trap rock, or green stones chapote is found.

Many of the Provinces of Prussia are rich in coal seams, and nume-

rous coal veins, or large seams, laying at considerable angles, at 1 in 2 and 3, in regular systematic but very curious positions, which promise to be most productive. In the Austrian Coal Fields the like have been discovered in the neighbourhood of Berlin, and more particularly still near the valuable port of Trieste, or between Trieste and Vienna. Austria possesses extensive and valuable coal districts, and is rich in other minerals, although their productive qualities have hardly been brought into competition with the wood fuel procured from the immense forests, which cover 43,896,637 acres, one-third of the productive extent of the empire. This is the case in consequence of the want of good roads, and particularly public railways, but as Government is now supplying both roads and railways to a large extent, the demand for wood will be much modified and coal brought into the market as a substitute.

Spain, Portugal, Lombardy, the Tyrol, and Hungary, all yield coal. In Bohemia coal is abundant. The bituminous coal of Western Bohemia is particularly good and plentiful. The basin of Rakonity is forty English miles from east to west, and ten or twelve miles from north to south.

Poland contains several coal areas, the working of which has been greatly neglected.

Sweden works mines of inferior bituminous coal to a very limited extent, owing to the easy importation of good coal from England.

In European Russia, to the Northern Shore of the Black Sea, bituminous Coal has been found in abundance. This is said to be equal to the best English Coal, and that it may be delivered at a port on the Dnepier or the Don, for 4s. or 5s ℔ ton. Little is known of the carboniferous system of Northern Russia. St. Petersburg is lighted with gas produced from English Coal. Norway and Holland exhibit no indications of Coal. Coal, said to resemble that of Scotland, has been found in the Egyptian Deserts. It has long been stated to exist in Abyssinia and tropical Africa. There is reason to credit a report that there are level beds about 500 miles East of Cape Town, and in Madagascar, Mozambique, and Port Natal.

Asia is rich in her deposits of bitumen and other hydro-carbonaceous substances, and there is also, good reason to believe that Coal exists extensively, and may be worked to profit in due time. At Eriki, in Anatolia, about 150 miles East of Constantinople, on the Southern Shore of the Black Sea, a formation, according to good authority, of Genuine bituminous Coal is said to be of considerable extent, of excellent quality, and

ted so as to be easily transported.* One hundred parts consist of:—

Carbon	62·40
Volatile matter	31·80
Earthy matter	5·8

Syrian coal abounds in sulphur, which unfits it for commercial ses.

Alexander Burnes states that large districts of bituminous coal in Cabul, situated favourably for transport.

Coal has long been known in Tartary, where its use is not only mentioned by Marco Polo, but by other early writers. Much coal is also ked in Japan, but no particulars have been published.

digenous coal of the bituminous species has already been discovered ore than one hundred localities in Hindostan, the best being that of udda and Burdevan districts, but no mines have been opened of sufficient importance to cause these districts to rank as coal producing countries, but steam navigation must in process of time force them into work, for an enormous price may be afforded for the coal since the freight of it from England is 40s. per ton, presuming always that there does exist a bed of coal, for until it is fairly worked, doubts must exist. In Bengal it appears that mining has been sufficiently carried on as to render the existence of workable coal quite certain.

China, if we look far into the future, will unquestionably become a coal producing country. We have evidence that amongst other varieties there exists tertiary or brown coal, bituminous coal of various kinds, cannel coal, and anthracite, all of which have for ages been in common use in that remarkable country.

Australia is rich in other mineral productions beside gold. At Newcastle and the Hunter region of New South Wales, bituminous coal is ascertained to be abundant. Sydney is (or may be) supplied with coal from Lake Macquarrie. The Australian Agricultural Company sold 27,000 tons from thence in 1840. In South Australia it has been reported that coal has been found, but it has not been verified. In Western Australia no coal has yet been found.

Coal is stated to be traceable quite across the Island of Van Diemen's Land, and in different parts of New Zealand it has been found in considerable quantities.

* There is no doubt of the existence of good Coal at Eriki. Under the superintendance of European Military Engineers, Coals are now been wrought for the use of the allied Fleets in the Black Sea, to the extent of 1,000 tons weekly.

FURTHER REMARKS ON AUSTRALIAN COAL MEASURES.

The following memoranda of the coal measures in Australia, are given from published reports and from MS. notes by Mr. Samuel Mossman—a well-known writer upon that country—which contain the latest and most authentic information relative to the subject :—

Coal has been discovered in seams of good quality, and of a workable nature for the purposes of commerce, in New South Wales, Van Diemen's Land, and, latterly, in Victoria.

The localities in New South Wales are on the Hunter River, in the district of that name, and on the Brisbane River, in the Moreton Bay district. The former were discovered in the earliest days of the colony, where they crop out on the sea coast at the mouth of the river in the vicinity of what was formerly a penal settlement named King's-town. Upon this discovery, its name was changed to Newcastle, after the famous capital of the land of coal and grindstones. The bluffs at the entrance of the river, some 200 feet high, show the width of the upper stratum, about 4 feet thick in the open face of day, a little distance above high water mark, with a westerly dip of 20 degrees. A mile or so from this spot, a shaft is sunk on a hill about 100 feet above the level of the river, where a seam of coal is worked, 5 feet in thickness, of the best Australian coal as yet discovered; which resembles the ordinary Scotch coals in quality, being less bituminous than the Newcastle coals generally. This mine is the property of the Australian Agricultural Company; and is so advantageously situated for shipping the fuel, that vessels can lie under a shute within a hundred yards of the pit's mouth, from whence the coals are discharged by means of a tram-way at a considerable declivity. In fact, the seam of coal is now being worked under the bed of the river, where the vessels lie at anchor, and the town itself is built above it. In this pit there is *no fire-damp*, consequently the workmen labour with ordinary candles and lamps without the gauze protector. The mode of working is exactly the same as that adopted amongst the Newcastle collieries in England. When the Company commenced operations they brought out 150 Newcastle pitmen and their families, with a viewer and overseers.

Until within the last few years these coal measures were worked under a monopoly, granted to the Australian Agricultural Company by the

ernment; but this has been successfully upset by some spirited land-
ers on the Hunter River, who possess coal on their properties, and
now work them in fair competition with the company. Among these
ate collieries, those on the Burrwood estate, three miles from the town,
stated to be more extensive and of better quality than the company's
s. The workings commence at the foot of a hill, where a tunnel is
through the solid coal, about five feet and a-half in height, and double
width, with an equal depth of workable coal above, the tunnel pas-
ough the hill, and opening out into a small valley behind. From
main tunnel there are two branch tunnels, half its width, running
o the hill, each of 200 yards in length, the working "bands" being
f the same dimensions, with a stratum of fire-clay eighteen inches thick-
is in projection to run these branch tunnels right through to the cliffs
the sea coast, many hundred yards distant, where the seams crop out,
hat this colliery will be an anomaly in coal mining. Here is no pit;
the workmen in many parts, will be able to pursue their labours by
light of day; while a tram-way to the wharf will convey the coal
along a level road, from the seam to the ship or wharf.

The seam of coal discovered on the Brisbane River at Moreton Bay partakes of the same character. The small portion of it which has been worked enters from the bank of the river, a few feet above its highest flood; and dips very gently to the NW. It is not more than 2 feet 3 inches thick; hence the workmen have to cut away a great portion of the shale to make room for themselves. This seam is supposed to be much wider further west, and has all the character at this spot of being the edge of a great basin where it thins out. The quality of the coal is much the same as that of the Hunter. In both of these seams, the carboniferous strata show the same succession of shales, clays, and sandstones as in England. Some of the former in my possession show beautiful fossil ferns and other Acrogens of the coal formation; besides some *coniferæ of the same rare type as the existing pines of Australia.*

The localities in Van Diemen's Land, where coal has been found are Port Arthur, and on the Douglas River. The quality of the former is so inferior in bituminous property that it requires to be mixed with an equal quantity of wood in the stove to continue burning. Hence the workings were abandoned when better coal was discovered on the banks of the Douglas River; of this mine I have no particulars, but I have seen the coal and it is equal to the New South Wales coal.

The localities where traces of coal fields in Victoria have been discovered, are in Western Port, in Bass's Strait, and extending 30 miles to

the eastward; along the eastern coast of Cape Otway, for a distance of 45 miles towards Port Philip; and in the vicinity of Geelong, over an area about 10 miles long and three wide, running north and south. This tract is known as the Barrabool Hills. It is not improbable that the two latter coal fields, although now many leagues asunder, are, in fact, portions of a continuous coal basin, in the same manner that the country drained by the Hunter River may be termed a vast coal field, each extending over an area greater than the geological basin of the Scottish coal fields.

In these three districts, the strata, in their character and general sequence, present a striking similarity to the carboniferous deposits of Great Britain. There is the same succession of numerous thin beds of shale, clay-stone, fire-clay, and sand-stone. The fire-clay is closely associated with the coal. There are, also, many seams of lignite and fragments of fossilised wood. Overlying the shales, coal, &c., is a thick mass of grey sandstone, variegated with red ferruginous veins, which present one of the most curious phenomena connected with the Australian coal fields. Imbedded in the soft friable sandstone are hard spherical bodies, or balls, and similar in position to the ironstone-balls of the South Wales coal field, but wholly different in mineral composition. These are silicious and crystalline, in colour resembling basalt, in size varying from 12 to 24 inches in diameter. Occasionally these balls lie in a horizontal tier, or band, and sometimes are scattered irregularly throughout the body of the rock.

The locality most likely to come into immediate use, is that of Western Port, where the seam crops out at Cape Patterson, on the sea beach, at an available distance—though presenting many obstacles—for water carriage to Melbourne. At this spot three seams appear. As no vertical section is exposed to view, and the outcrop is half buried under sand and water, it is not easy to determine the thickness with accuracy. The middle seam is, apparently, the widest, being about four feet thick with a dip of 20° west. The quality of the coal is better than any hitherto discovered in Australia. It has a bright waxy lustre, with a splintery choncoidal cross fracture—minute crystals of iron pyrites studding the fissures. Specific gravity, 1·30. Its calorific power, as determined by Berthier's method, with lead oxide, is 86 to Newcastle coal as 100. It produces a coke of excellent quality, weighing 60 per cent. of the mineral.

Altogether there is good data to calculate from, that in South-Eastern Australia coal fields exist in the same proportion to its extent as those

and that the quality of the mineral for use is about the as what is found in that country. Of course this applies only to olonies of New South Wales, Van Diemen's Land, and Victoria. uth Australia, Western Australia, and the territory in the vicinity ne abandoned settlements in North Australia, no evidences of coal e hitherto been discovered. While in the New Zealand group of d, what the settlers term *coal*, is nothing but a compact description *ite*. And it is a question whether these islands—generally speak- f recent formation—possess any stratified rocks of the carboniferous

re is no country at the present time, within the British dominions, ch present a more lucrative field for the capital and experience of the tical coalowner than Australia. Upon the Hunter River alone there om for quadruple the capital invested and labour employed, without chance of diminishing the net profits, which range from 20s. and ards upon every ton produced. The supply of coal is practically inexhaustible; while the markets for consumption are increasing to an incalculable extent. There is an unlimited export trade to Peru, Chili, Mexico, California, and the settlements in the South Sea Islands; and an increasing intercolonial trade with New Zealand, Van Diemen's Land, Victoria, South Australia, and Western Australia, besides a growing *home consumption* in New South Wales—all of which is sea-borne coal. What the increase may be when the railways are established, which are now in progress, it is impossible to say; but the subject is worthy the attention of coalowners, with spare capital, in Britain; and I can confidently assert that they would be conferring a great boon upon the Australian colonists, by thoroughly testing the extent of this branch of the mineral wealth of their adopted country.

NOTE.—The foregoing statements, Chapters XVII. and XIX., will show how quickly Durham and Northumberland counties have increased their collieries tenfold; and Chapter XXV. will show how America and all other countries have also increased, while Britain is still burning a little peat and wood for firing. The foreign countries use, to a large extent, the same fuel, independent of coal and coke, even still with steam engines on both railways and rivers. The different railways, or projected railways, in Australia are, unfortunately for that country, proposed on three different guages—one 4ft. 6in., the other 5ft. 6in.; and Mr. Brunel has proposed the third, 5ft. 3in.; but even these differences will not affect the consumption of fuel when they are in operation; they, of course, will do then, as all other countries have done, very much to increase the demand for coal for home consumption, and also what may be hereafter required for the different extensive manufactories that will no doubt ere long be established.

ERRATA.

Page.	Line.	
107	20	for *Copley Bent, in the Parishes of Langsack-cum-Softley*, read *Copley Bents, in the Township of Lynesack-cum-Softley.*
108	3	for *Garsefield* read *Garesfield.*
108	5	for *Westward Bywell* read *Westward at Bywell.*
108	11	for *Widderington* read *Widdrington.*
108	26	for *East* read *South.*
111	16	for *Coley Hill* read *Coaly Hill.*
111	24	for *Coley Hill* read *Coaly Hill.*
112	7	for *Tadhoe* read *Tudhoe.*
114	16	after "iron stone" add *South of Cockfield Fell Dyke.*
115	12	for *Hunscliffe* read *Huntcliffe.*
115	15	dele "or shipped at Redcar."
115	23	for *Baring, Brothers and Co.* read *Charles Attwood and Co.*
116	30	for *Redcar* read *Middlesbro'.*
118	1	for *Garmonsway* read *Gardmonsway.*
119	21	for *he holds* read *he held.*
122	27	for *crops* read *crosses.*
123	4	for 1774 read 1771.
125	26	for *Hylton* read *Heaton.*
125	5th from bottom, for *peoples* read *people.*	
127	8	for *North* read *South.*
128	6	for *W. W.* read *W. B.*
130	10	for *Cowdon* read *Coundon.*
144	9	for *seams* read *seam.*
149	last line, for *drawing* read *draining.*	
159	1	for *Copley Bent* read *Copley Bents.*
159	10	for *river* read *rivulet.*
162	26	for *Earl of Crawford and Ballcaris* read *Earl of Balcarres.*
165	31	for *Ratcliffe* read *Radcliffe.*
168	3	for *Hutto* read *Hutton.*
169	10	for *Comesforth* read *Cornforth.*
170	4	for *Stoneylodge* read *Storeylodge*, and for *Lunds* read *Lands.*
179	18	for *Shadworth* read *Shadforth.*

NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS.

GENERAL MEETING OF THE INSTITUTE, HELD IN THE LECTURE ROOM OF THE LITERARY AND PHILOSOPHICAL SOCIETY, NEWCASTLE UPON TYNE, MAY 4, 1854.

NICHS. WOOD, ESQ., PRESIDENT OF THE INSTITUTE, IN THE CHAIR.

The minutes of the last General Meeting and of the Council Meetings held since were read and confirmed.

Messrs. Errington, C.E., Benjamin Arkless, Munde, and Thos. Chas. Thompson, were elected ordinary members of the Institute.

The President then said that as only part of Mr. T. Y. Hall's paper "On the Extent and Probable Duration of the Northern Coal Field" had been read at the last meeting, no discussion on it would be held until the remainder was read, and as it was very long and would occupy the whole time of the meeting he would not detain them by further observations.

The Secretary then proceeded to read the remainder of Mr. Hall's paper.

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NORTH OF ENGLAND INSTITUTE

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MONTHLY MEETING, THURSDAY JULY 6th, 1854, IN THE ROOMS OF THE INSTITUTE, WESTGATE STREET, NEWCASTLE-UPON-TYNE.

THOMAS JOHN TAYLOR, ESQ., IN THE CHAIR.

The Minutes of the last General Meeting having been read and confirmed,

Messrs. Chas. Binns, William Stenson, jun., — Ashton, John Mercer, J. W. T. Bell, J. L. Bell, and H. Mulcaster, were elected ordinary members of the Society.

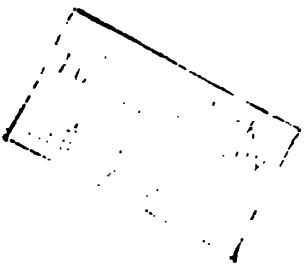
The CHAIRMAN then observed that this was the proper time for discussing the subject of the paper read by Mr. T. Y. Hall at the last meeting, but as Mr. Hall was not present, and the subject was understood to be not yet exhausted by him, it was deemed advisable to postpone the discussion. He also took the opportunity of stating that the next meeting of the Society (on the 3rd August) would be the Annual Meeting, and it was presumed, also that of the customary dinner. He remarked that though the convivial meeting in question passed off so well last year, yet it was generally thought that an improvement might be effected by making the price of the ticket 12s. 6d., and he, therefore, put it to the meeting whether such had to be the cost, or whether the former price of 10s. 6d. had to be maintained.

The meeting hereupon unanimously declared their opinion that the tickets should be 12s. 6d. each.

The SECRETARY then proceeded to read a paper, with very complete plans and sections, by Mr. Thos. Hedley, on "Mines and Mining in the North Staffordshire Coal Field," Mr. Hedley himself being absent.

The CHAIRMAN complimented the author on the very excellent memoir which had just been read, and added that communications of this nature tended specially to show the value of the Institute, in bringing under one view the mining practice of distant parts of the country, and thus furnishing information which could hardly be obtained by individuals in any other manner, or without at all events great expense and inconvenience. He added that as the Institute had now members in all the various mining districts in the kingdom, as well as on the Continent, the result of their communications would, for the reasons given, prove, it could not be doubted, of the most beneficial character.

It was then resolved—"That a vote of thanks be given to the Committee of the Coal Trade for the very handsome and tasteful manner in which they have provided for the accommodatian of the Society at the new rooms in Westgate Street."



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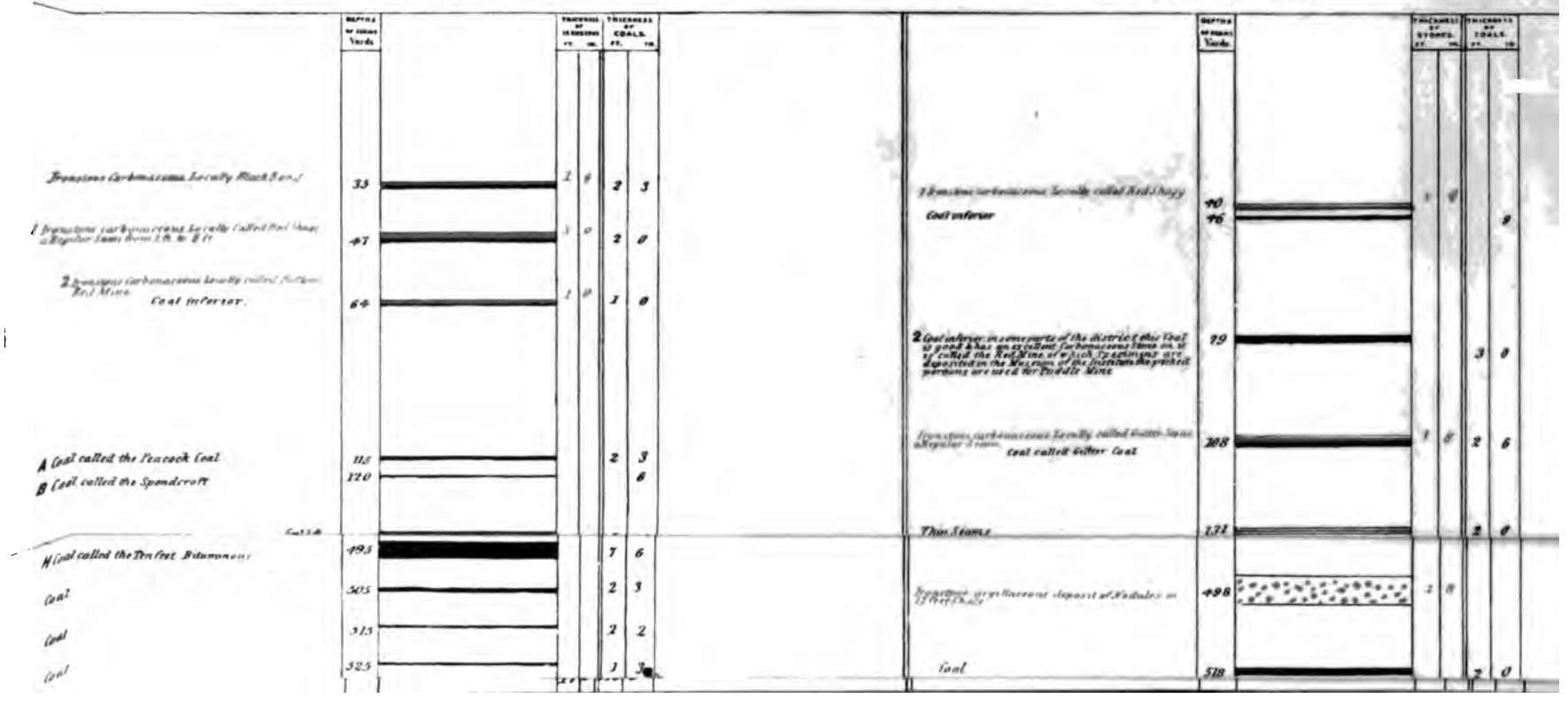
NORTH STAFFOR

SECTIONS OF MINES.

West side of Basin
Silverdale Colliery

East side of Basin
near Burslem



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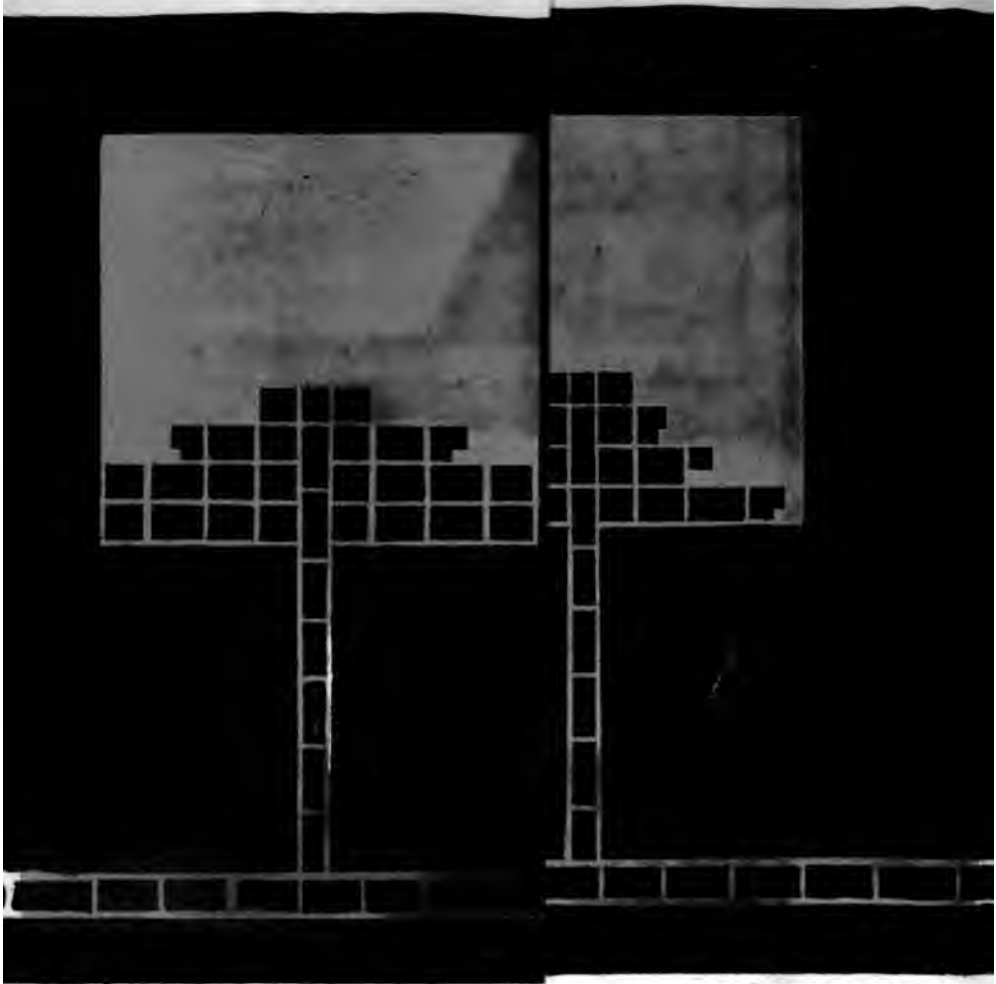
ASTOR, LENOX
TILDEN FOUNDATIONS

Sketch Nº 2.



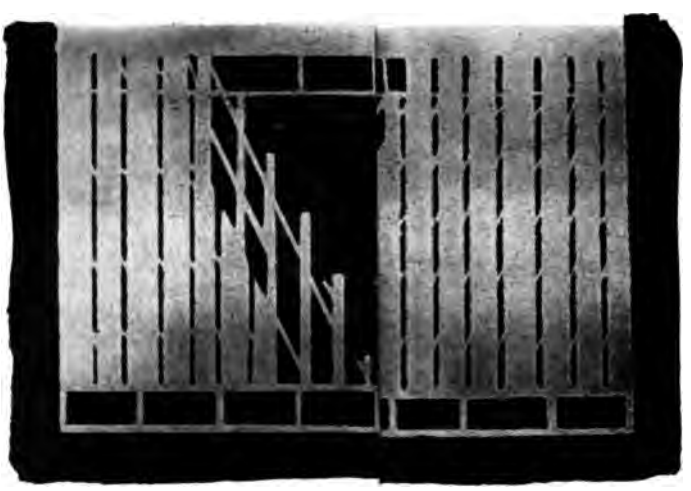
Reid, Lith. Pilgrim St Newcastle

Scale 180 f^t to 1 inch.

Sketch N° 3

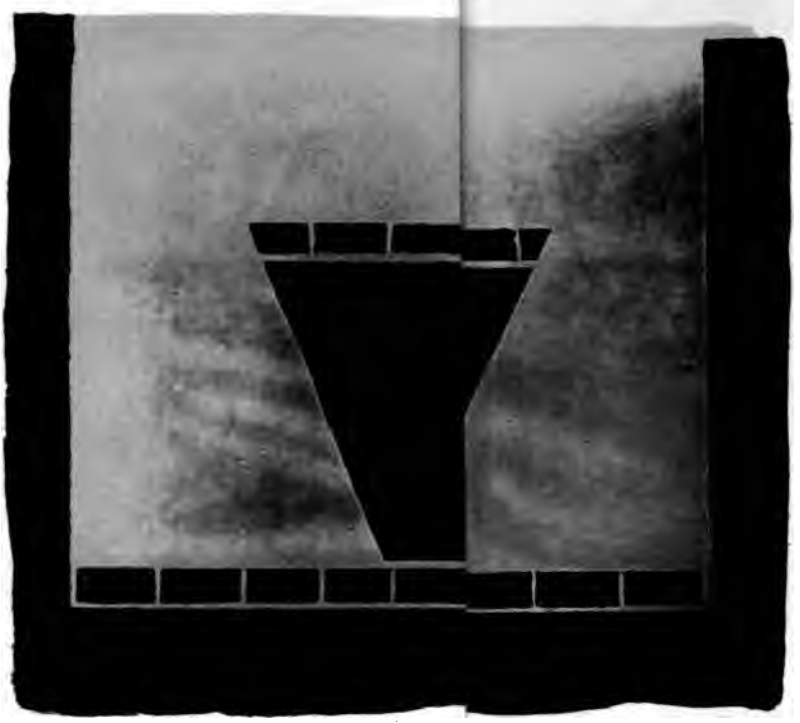
Scale 180 f^t to 1 inch.

Sketch N° 1



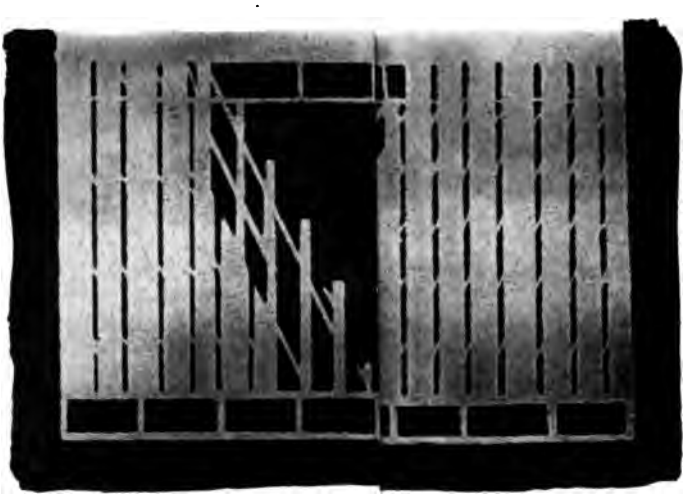
Scale 180 f^t to 1 inch.

Sketch N° 3



Scale 180 f^t to 1 inch.

Sketch N° 1



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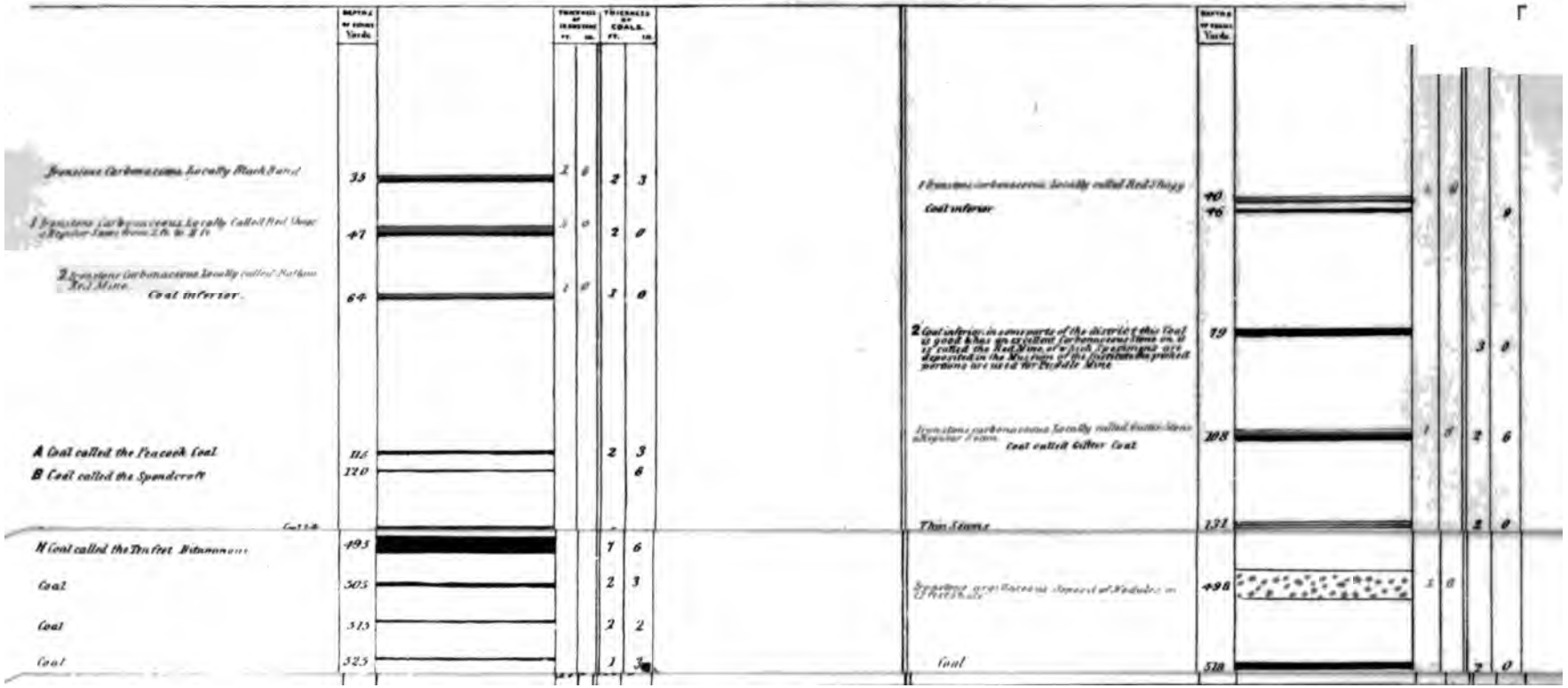
NORTH STAFFOR

SECTIONS OF MINES.

West side of Basin
Silverdale Colliery

East side of Basin
near Burslem



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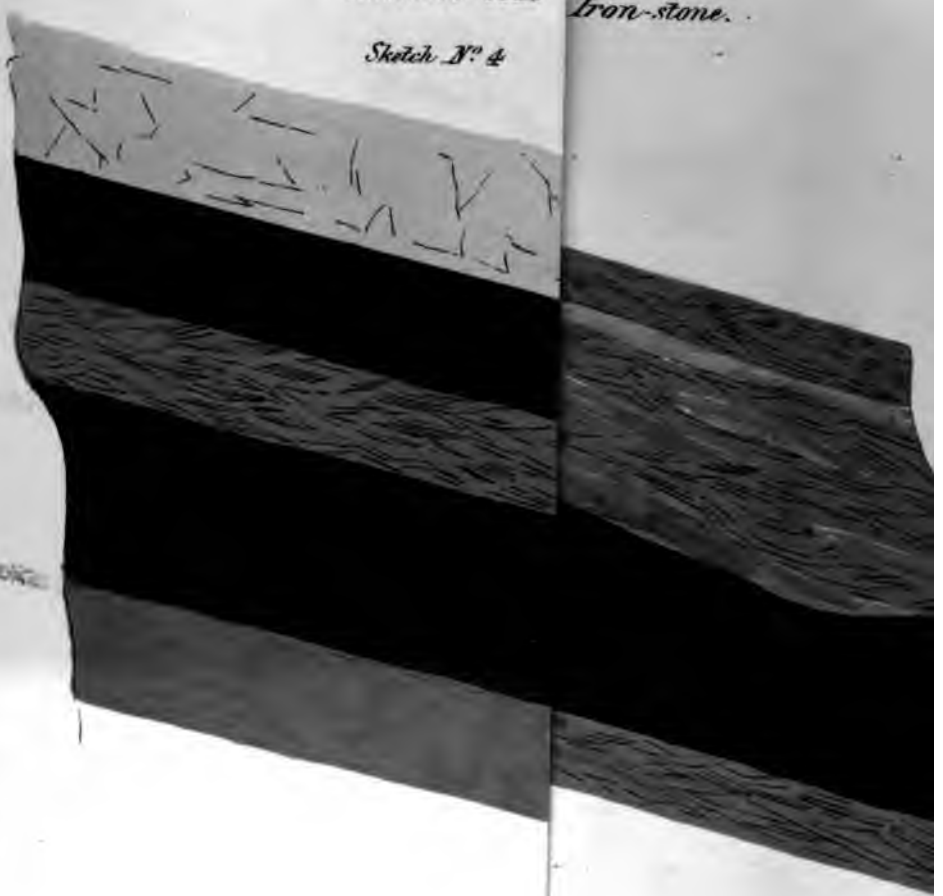
Rowhurst Coal Iron-stone.

Sketch No. 4



THE N
PUBLIC
ASTOR, LENOX
TILDEN FOUNDATIONS

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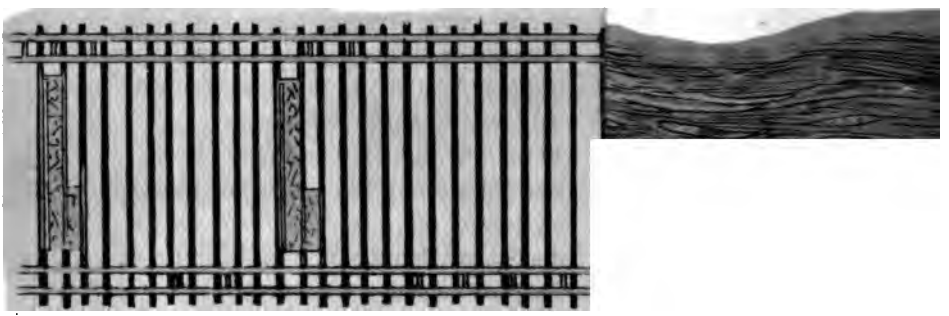
ROWHURST LONG WORK. SKETCH Nº 10

Transverse Section.

Scale 12 feet-1 inch.

GOAF WORK FOR I GOAF WORK. SKETCH Nº 12

Scale 8



MINES AND MINING

IN THE

NORTH STAFFORDSHIRE COAL FIELD.

By JOHN HEDLEY.

The North Staffordshire Coal Field, including a small area in the county of Chester, extends over 38,000 statute acres, this is exclusive of that part of the basin overlaid with the new red sandstone, underneath which mines have not been explored. On the west and south sides of the basin, the mines dip under the red sandstone, on the east side the outcrop is fully developed; with an inclination of from 9 inches to 18 inches to the yard. The country intervening between this coal field and that of the Derbyshire is occupied with the millstone grit and carboniferous limestone, except a small detached coal field of the lower seams, near Cheadle, six to seven miles beyond the outcrop of the main field.

At A on map of the coal field, the millstone grit has been forced through the coal measures to an elevation of 300 feet above the surrounding district, and forms a considerable hill called *Mow cop;* this elevation of the grit appears to be on the range of an off-shoot from the internal disturbance, which has formed the great anticlinal axis running north and south through Derbyshire. The off-shoot extends round the north and western edges of the visible coal basin, the mines being much distorted and dislocated, every angle of inclination from a level plane to a vertical position being met with.

What is locally called the Saddle is found on the western edge of the basin. It is a minor anticlinal axis, running north-east and south-west, the summit for a considerable breadth being flat, from which the mines dip, much dislocated on both sides. From the manner in which the continuity of the axis is broken, it appears to have existed prior to the main fault which passes through it.

Faults are very numerous, the largest proved being upwards of 800 yards downcast to the east, and is shown on the map to the west side of basin. The main fault on the east side of basin is about 80 yards upcast to the east, having an inclination of 18 inches to the yard.

The strata of the upper series are chiefly argillaceous; neither shafts nor tunnels will stand without being protected from the atmosphere. Beds of fire-clay 15 yards thick are met with; the great and cheap abundance of this material, coupled with the peculiar quality of fuel, have no doubt been mainly instrumental in making this district the metropolis of the earthenware manufacture. This branch of industry having, in the first instance, being the means of developing the coal field, it may not be out of place to give a few statistics of the trade. Upwards of 800,000 tons of coals and slack are consumed annually in the manufacture of earthenware in the Potteries; and 50,000 tons of fire-clay in making saggers or pots, in which the ware is baked. The annual value of goods made being about £2,500,000. 2,000,000 tons of coals and slack are annually raised, and 500,000 tons of ironstone or about 320,000 tons of calcined stone.

Where the whole of the mines do exist there are 156 feet thick of coal in seams above 2 feet; and 12 feet thick of coal in seams under 2 feet and above 1 foot; and 23½ feet thick of ironstone. If the whole of the workable mines were spread over the extent of the basin the thickness would be 32 feet of coal and 5 feet of ironstone.

The ironstone is met with in regular seams, in rich deposits of septaria and nodules, and comprise carbonaceous stone, silicious stone, and argillaceous stones. A regular seam of calcareous stone, 13 inches thick, is also go in the carboniferous limestone strata, 8 miles to the east of the coal field.

With such valuable deposits of ironstone, that may be mixed to flux well in the furnace, great facilities are afforded for the manufacture of iron. On the east side of the coal field are found the best beds of stone, but, owing to the great depth to the furnace coals on the royalties in which stone is found, the make of iron has been curtailed. This drawback will not exist long on some royalties. The Earl of Granville, under

the advice of Mr. John Lancaster, has recently made a winning, 250 fathoms deep, to furnace coals. The Stoney Eight Feet, Rough Seven Feet, and Sparrow Butts are good furnace coals, on the east side of basin.

A project is now before Parliament to connect by railway the ironstone producing districts with districts in which furnace coals can be cheaply won; if the railway is formed a great stimulus will be given to the iron manufacture in North Staffordshire.

On the west and north sides of basin, the deposits of stone are not so rich as those on the east, but the fuel is more accessible, but not so good for iron making. The coals on the east side are free burning, and to some extent used raw in the furnace; on the west side they are chiefly bituminous. The coal coke is made in open fires for the furnace.

The carbonaceous stones contain sufficient carbonaceous matter to calcine or roast them, and are carefully piled up in stacks containing from 500 to 1,000 tons. The process of burning requires a fortnight, and and from 50 to 66 per cent. in weight is lost. The calcined stone yields about 70 per cent. of iron, by analysis, but only 50 per cent. in the furnace.

The silicious and argillaceous stones require about one-eight their weight of coal, and one-twelfth of slack to calcine or roast them. These stones are also piled up in stacks from 500 to 1,000 tons, and require a fortnight for the process of calcining, and lose from 30 to 36 per cent. in weight, yielding in the calcined state about 65 per cent. of iron by analysis, and in the furnace 50 per cent. The calcareous stone is used raw in the furnace, and is prized as a flux.

Twenty furnaces are in blast (all hot blast, and five erecting and several contemplated), in the district producing annually upwards of 100,000 tons of pig iron. Our average produce per furnace weekly at the Silverdale Iron Works throughout the year is about 150 tons.

We use $2\frac{1}{8}$ tons of coals and 13 cwt. of slack, coked, 2 tons calcined stone, 11 cwt. limestone in the furnace, 19 cwt. of slack for the hot blast apparatus and blast engine to make one ton of pig iron. With the above burden and using $\frac{1}{3}$ carbonaceous mine, $\frac{1}{3}$ argillaceous, and $\frac{1}{3}$ silicious, we make good grey forge, some foundry and strong white iron. These qualities are more profitable than higher numbers, of which very little is made or called for in the district, the demand being chiefly confined to foundry iron, and pigs for conversion into bars.

Make of iron and consumption of material at two furnaces belonging to the Silverdale Company, situate on the west side of the basin, for the

week ending 15th of February, 1854, equal proportions of carbonaceous, silicious, and argillaceous mine being used.

Mine used.	Coals made into Coke.	Slack made into Coke.	Limestone used.	Slack used for Blast Engine.	Slack used for Hot Blast.	Iron made.		Total make.
						No. 1 Furnace.	No. 2 Furnace.	
Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
660	703	218	140	173	140	157	173	330

	No. 4.	Grey Forge.	Mottled.	Strong White Iron.	Total.
	Tons.	Tons.	Tons.	Tons.	Tons.
Quality of make	69	200	19	42	330

Three bar iron works, Kidsgrove Works, Ravensdale Works, and Shelton Bar Iron Company's Works are in operation, producing about 1,100 tons of bar iron, boiler plates, and hoops weekly, considered by many to be equal in quality to the South Staffordshire iron. Two bar iron works are now erecting, in addition to the above, capable of making 500 tons of manufactured iron weekly. The surplus pig iron of the district is chiefly purchased by the makers in South Staffordshire. Owing to prejudice (arising from interested motives), which is now fast passing away, the North Staffordshire pig iron does not realize so much per ton, by 10s., in South Staffordshire as the South Staffordshire iron, yet the South Staffordshire makers buy it to mix with their own, make it into bars and return it through North Staffordshire to the Liverpool market, entailing a cost of more than 10s. per ton in carriage on the pig iron made into bars in South Staffordshire over that manufactured at home; a good margin to enable the maker of this district to compete successfully with the South Staffordshire makers. This district has also an advantage over the south in the cost of producing the raw material. We raise and prepare iron-stone for the furnaces at about one-half the cost; and fuel also at a much less cost.

Above one hundred thousand tons of calcined stone are now annually sold to the iron masters in South Staffordshire, who use about one-seventh in the furnaces, and can afford to pay 16s. to 17s. per ton when trade is brisk, and the carriage additional, about 5s. per ton. Puddling mine is also sent to the south, realizing 4s. to 5s. per ton more than the furnace mine. The picked calcined portions of the carbonaceous stones are used for puddle mine.

It is about twenty years since the iron-stones of this district were turned to profitable account in the manufacture of iron; previous to that time some of the carbonaceous stones were worked to repair roads, their properties not being known.

In the roof of the Burnwood coal, on part of the east side of the basin, a very valuable stone exists; it is a deposit of carbonaceous stone, argillaceous stone, and silicious stone, distributed in 6 feet of dark shade. Twenty years ago the coal was got under part of a royalty, now under my management, and the stone left. I have sunk to the stone and raised a considerable quantity of excellent iron-stone. Owing to the broken state of the strata it is a very difficult task to get, I can only compare it to an old pit heap in many places. *Sketches, Nos.* 11 *and* 12 shew the plan of working.

The mining leases are usually upon the ton of 2,400 lbs. A rent from 8d. to 14d. per ton being paid for coals and one-half these prices for slack. From 10d. to 20d. per ton of 2,400 lbs. is paid for calcined iron-stone. When coals and iron-stone are consumed at the works, a charge is made on the pig iron, from 3s. 6d. to 4s. 6d. per ton, to cover the rent for coals, slack, and iron-stone used.

SECTIONS OF MINES.

Few records of the strata have been kept. I have no doubt there are other iron-stones in the upper series besides those noticed in the sections. I have carefully examined the strata when I have had the opportunity, and also compared the records of sinkings, in my possession, with new sinkings. I think the following sections will be found accurate.

The strata from the Penny-stone to the Rowhurst coal (east side of the basin) has not, through lack of opportunity, been carefully examined by me.

The names of some seams are taken from the locality in which they have been first worked. Others from peculiarities of the coals. The cannel row for instance, has a band of cannel in it near the top. The peacock coal is marked with the prismatic colours.

The term *Row*, means Seam. It is of frequent occurrence in naming the coals.

SECTION, SILVERDALE, WEST SIDE OF BASIN.

	Depths to Seams.	Thickness of Stones.		Thickness of Coals.	
	Yards.	Feet.	Inches.	Feet.	Inches.
Top red mine (carbonaceous stone), inferior, not worked					
Black band stone (carbonaceous stone	35	1	6		
Do. coal	..	..	..	2	3
Red shag stone (carbonaceous stone)	47	3	0		
Coal	..	..	..	2	0
Bottom red mine (carbonaceous)	64	1	0		
Coal	..	..	..	1	0
Peacock coal, free burning, used in the manufacture of earthenware, east side of basin	115	..	..	2	3
Spendcroft coal	120	..	..	0	6
Great Row, free burning:— ft. in.					
Coal 2 0					
Shale 1 6					
Coal 3 6					
	140	..	..	5	6
Cannel mine stone (argillaceous.), in 3 bands, deposited in 4 feet of dark shale	155	0	9		
Cannel Row coal free burning, used in the manufacture of earthenware and bar iron	160	..	..	6	0
Carried forward		6	3	19	6

SECTION, SILVERDALE, WEST SIDE OF BASIN.

	Depths to Seams.	Thickness of Stones.		Thickness of Coals.	
	Yards.	Feet.	Inches.	Feet.	Inches.
Brought forward	..	6	3	19	6
Little mine coal, inferior	179	..	..	6	6
Stone (argillaceous), a deposit of Septaria, in 3 feet 6 inches of dark shale	190	0	8		
Stone (argillaceous), 4 bands, in 3 feet 6 of shale	200	0	10		
Black stone (argillaceous, and contains some carbonaceous matter), 4 bands, deposited in 3 feet 6 inches of dark shale	210	0	10		
Rusty mine stone (argillaceous)	220	0	6		
Chalky stone (argillaceous), deposit of Septaria, in 12 feet of shale	242	3	0		
Stone (argillaceous), 7 bands, deposited in 4 feet of shale	250	1	1		
Stone (argillaceous), a deposit of Septaria, in 3 feet shale	260	0	8		
Brown mine coal, inferior	275	..	..	4	6
Do. stone (argillaceous) a regular bed, shale roof	280	1	9		
Top thick band stone (argillaceous)	300	0	6		
Middle ditto (ditto)	305	0	6		
Bottom ditto (ditto)	320	0	6		
Coal	320	..	..	1	2
Silverdale coal, free burning	360	..	..	2	9
Four feet coal, semi-bituminous	395	..	..	4	3
Two feet coal, free burning	402	..	..	1	8
Single five feet ditto	410	..	..	4	9
Good furnace coals: Ragman coal (semi-bitum.)	435	..	..	3	6
Good furnace coals: Rough seven feet ditto	438	..	..	6	0
Good furnace coals: Hams coal ditto	443	..	..	4	6
Coal	457	..	..	1	3
Stony eight feet coal. The best furnace coal on the north side of the basin, where it is 4 feet 6 inches thick	465	..	..	1	6
Ten feet coal (bituminous)	495	..	..	7	6
Top two row coal	505	..	..	2	3
Bottom do.	515	..	..	2	2
Clod coal	525	..	..	1	3
Bowling-alley coal	538	..	..	1	6
Coal	575	..	..	1	0
Seven feet nabs (bituminous)	600	..	..	5	0
Eight feet nabs (do.)	630	..	..	5	0
Coal	645	..	..	1	0
Coal	660	..	..	1	3
Coal	675	..	..	1	3
Bullhurst coal (bituminous)	705	..	..	6	6
Coal	735	..	..	3	0
Coal	770	..	..	2	6
Coal	820	..	..	2	6
Coal	860	..	..	3	0
Coal	920	..	..	2	6
Coal	960	..	..	2	9
Coal, called Biddulph Moor coal	975	..	..	2	6
Total		17	1	116	3

SECTION, EAST SIDE OF BASIN, NEAR BURSLEM.

	Depths to Seams.	Thickness of Stones.		Thickness of Coals.	
	Yards.	Feet.	Inches.	Feet.	Inches.
Ironstone (carbonaceous), called red shagg	40	1	0		
Coal, inferior	46	..	..	0	9
Coal. In some parts of the district this coal is very good, and has an excellent carbonaceous stone on it, called the 'Red Mine," the picked portions are used for Puddle Mine..	79	..	..	3	0
Ironstone (carbonaceous), called gutter stone ..	108	1	8		
Coal	108	..	..	2	6
Three thin seams of coal	131	..	..	2	0
Coal	138	..	..	3	0
Inferior coal and cannel	167	..	..	3	0
Ironstone (carbonaceous), called bassey mine, and varies in thickness from 1 ft. to 6 ft...	194	4	6		
Coal	194	..	..	2	9
Coal	203	..	..	1	6
Coal, called peacock coal.....	216	..	..	5	0
Coal, called spendcroft.....	236	..	..	4	0
Ironstone (argillaceous), 4 bands, deposited in 4 ft. 6 in. shale.....	251	1	0		
Coal, called great row, used in the manufacture of earthenware	267	..	..	7	6
Coal, called cannel row, with a band of cannel near the roof 6 to 9 in. thick	297	..	..	6	0
Inferior coal	..	..	..	2	0
[This coal is used in the manufacture of bar iron. In some parts of the district this seam has 9 in. of carbonaceous stone on the roof.]					
Ironstone (argillaceous), regular band	309	0	8		
Wood mine, inferior carbonaceous stone.....	323	1	0		
Do., coal inferior	323	..	..	1	0
Ironstone (argillaceous), called penny-stone, bottom part a regular band 13 in., top part, septaria, 5 in.	329	1	6		
Ironstone (argillaceous), deposit of septaria in coal roof, ...	336	0	10		
Coal, called deep mine, inferior	336	..	..	3	0
Ironstone (argillaceous), deposit of septaria in 3 ft. shale	377	1	0		
Coal	377	..	..	1	0
Ironstone (carbonaceous), regular band.....	357	1	8		
Coal, good	357	..	..	2	0
Coal	442	..	..	2	0
Coal, called wing hay, free burning	450	..	..	4	6
Ironstone (argillaceous), regular bed	474	1	6		
Ironstone (argillaceous), deposit of nodules, in 12 ft. shale	498	1	6		
Coal	518	..	..	2	0
Coal, Rowhurst Seam	542				
Free burning, and used for manufacture of earthenware. — Top coal, good.....	..	..	..	3	6
Thill, 30 in.					
Middle coal, good.....	..	..	..	6	0
Thill, 30 in.					
Bottom coal, inferior..	..	..	..	3	0
Ironstone (argillaceous), nodules, in 3ft. 6in. shale	552	1	0		
Carried forward		18	10	71	0

SECTION, EAST SIDE OF BASIN, NEAR BURSLEM.

	Depths to Seams.	Thickness of Stones.		Thickness of Coals.	
	Yards.	Feet.	Inches.	Feet.	Inches.
Brought forward	..	18	10	71	0
Coal	555	..	..	0	9
Ironstone (argillaceous), two irregular bands in 3 ft. shale	556	1	2		
Coal, with inferior silicious ironstone on the top	573	0	10	1	6
Ironstone in roof of coal, a deposit of carbonaceous, siliceous, and argillaceous stone, in septaria. The silicious stone in septaria covering 200 to 400 square yards, and upwards of 36 ins. thick in some places.....	582	2	6		
Coal, called Burnwood, free burning	582				
Top part, good..... 3 ft. 0 in.					
Middle, shaley..... 0 9					
Bottom, inferior 2 3	..	..	..	6	0
Coal, called twist coal	606	..	..	3	0
Coal	630	..	..	1	0
Coal	693	..	..	1	0
Coals.. { 1st Coal ..... 2 ft. 6 in. / Thill ..... 3 6 / 2nd Coal ..... 1 8 }	765	..	..	4	2
Coal, called Mossfield, one of the best house coals in the district, free burning, has a very bad roof, dark shale; all the going roads require to be brick arched in some works	789	..	..	4	0
Thin coal ..... 0ft. 6in.	..	..	..		
Thill, ... 0 6					
Coal 1 6	799	..	..	2	0
Coal	809	..	..	2	2
Coal, called Ragman, free burning and a furnace coal. Lord Granville has recently sunk to this seam at a depth of 250 fathoms.....	870	..	..	4	0
Coal, called Rough seven feet furnace coal	890	..	..	5	6
Coal, called Stoney eight feet, or Hams. The best furnace coal on the north side of the basin, where it is 4 to 6 inches thick.....	930	..	..	3	0
Coal	950	..	..	2	6
Coal called 10ft. free burn., good coal for potters	975	..	..	5	6
Coal, called Bowling Alley, free burning, good house coal	1000	..	..	3	0
Coal, called Holley Lane, free burning, one of the best house coals	1035	..	..	3	6
Coal, called Sparrowbuts, free burning, good furnace coal	1055	..	..	4	6
Coal	1083	..	..	3	0
Coal, called Bambury, free burn., good house coal	1111	..	..	4	6
Coal, called Cockshead, free burn., good housecoal	1190	..	..	7	0
Coal	1210	..	..	2	6
Coal, called Bullhurst	1250	..	..	4	6
Coal	1280	..	..	3	0
Coal	1306	..	..	2	6
Coal	1356	..	..	2	6
Coal	1396	..	..	3	0
Coal	1456	..	..	2	6
Coal	1486	..	..	2	9
Coal, called Biddulph Moor coal.....	1500	..	..	2	6
Total		23	4	168	4

REMARKS ON MINING.

Previously to the last two or three years mining operations were conducted generally in a very primitive manner. Mr. Woodhouse being the first to lead the way to improvements, followed by Mr. Lancaster and myself.

It was formerly the practice of the district managers to begin working at the outcrop of the seams and progress towards the deep, until stopped by water overpowering a water bucket drawn by the engine. At present, the pumping power of the district amounts to about 2,000 horses. Royalties have not been separated by barriers; and, in some instances, large dykes, forming natural barriers, have been cut. Had mining operations been conducted with that foresight and forethought so necessary in carrying them out, the collieries would have been troubled with very little water. The strata are chiefly argillaceous and impermeable.

The inclination of the strata is generally very great, almost every seam in the basin comes to the day. In no instance that I know has the coal been left solid to the day to keep back floods of surface water. At one pumping engine I have at work, raising water 80 fathoms, the engine feels a good shower of rain in two or three days after the ground is saturated. Owing to these sudden influxes of water more than double the pumping power has to be provided at many of the collieries.

Shafts have, hitherto, been sunk from 5 feet to 8 feet diameter; one rope to draw coals in a shaft and without guides. From 10 tons to 450 tons being about minimum and maximum quantities raised weekly from a shaft. Some of the old school pride themselves upon drawing from 6 or 7 shafts, with one engine, and raise 200 to 500 tons from the lot.

The butty system is universal; he contracts to deliver coals and slack into carts and waggons at bank, at a price per ton; also, a price per cubic yard, for stone stacked on the bank. At some collieries the butties have to find all materials and labour (except tramways and engines), to put the coals on the bank. The butties are, in many instances, the

managers likewise; after they take a pit, their doings are sometimes not overlooked for months. The mode of getting the coal is left to their own judgment. The colliers, putters, &c., are usually engaged by the day; a more sluggish race of pitmen never came under my notice. I have lately succeeded in putting several pitmen and putters, under me, at work by contract.

When I was made acquainted with the mode of conducting mining operations, it was no surprise to hear that collieries, situate with every circumstance favourable for returning good profits (coals being 7s. 6d. per ton, on the bank), were with difficulty paying their way.

If the local system of conducting mining operations is not superseded by improved methods, a great portion of the basin will remain ungot. The deepest colliery, now working on the Staffordshire system, is 100 fathoms, and the cost of putting a six feet seam on to bank, amounts to near 7s. per ton. Having been consulted about this colliery, I speak from facts.

The mines are worked by two arrangements of post and stall, locally called punch and thirl, and cross heading *(See Sketches Nos.* 1 *and* 3*)*, and by long work *(See Sketch No.* 2*)*. It is the practice here, whether the seams are much inclined or not, to arrange board and pillar workings so that the goaf may lay on the dip of the face of the work. The inclination of the seams tends to throw the pressure from the face of the work. Some of our coal fields would be greatly benefitted by generally adopting this arrangement; which is to some extent practised in most coal fields.

In working post and stall, punch and thirl *(see Sketch No.* 1*)*, the levels are driven out either to the boundary or to a determined distance before the getting of coal begins, which is got towards the shaft. A breadth of 70 to 100 yards is got by means of a pair of levels. The operation of removing the pillars follows, one pillar length back from the face of the boards. In getting the pillars the operation commences at the bottom end, and is carried forward to the next opening or thirling to the rise, sufficient coal being left to support the roof until the pillars are stripped. The coals from the pillars are brought through the second opening back from the face of the boards. By this plan of working, from 15 to 25 per cent. of the mine is left. The coals and slack are removed from the mine on sleds (locally called corves). Large coals are placed on the sled, upon these coals a wooden or iron ring is placed and another layer of coals, is placed on it and so built up to a height of 6 feet in some pits. The loads vary from 10 cwts. to 20 cwts. Horses

drag the load from the workings along the floor of the seam down to the level road, where it is drawn on to a waggon and conveyed to the pit bottom, and then the tackling chains are attached to draw the load to bank. The process at bank is, push a large waggon or door over the shaft mouth, push another waggon upon this to receive the load, and the whole is removed either by the banksman or an ass. The tackling chains are taken off, the load drawn down the bank or set, which is inclined, and by a jerk of the banksman, the load is upset, to be gathered up and put into carts or waggons. The cost of loading the coals into waggons, &c., is 2d. to 3d., per ton. The cost of conveyance underground along the levels is 1s. per ton per mile.

Sketch No. 3 shews another method of working by board and pillar, locally called cross-heading. The boards are driven on the level course; the pillars are got out towards the rise. A pair of winning boards (dips), are driven 100 to 150 yards apart, one-half of the intervening block of coal being got to each pair of boards.

Sketch No. 2 shews the method of working by long work. The levels are usually driven 70 to 100 yards apart. The coal got back towards the shaft. The face of the work is formed at an angle of 45° or so to the level course, in order to ease the labour in drawing the sleds up. The coals are brought to the levels either by horses or manual labour, the same as is in board and pillar work.

Sketches Nos. 4 *and* 5.—Sections of two seams, the first called the Rowhurst, the latter the Burnwood. In both seams I have introduced long work, having hitherto been got by board and pillar (punch and thirl). When colliers wages were 3s. 6d. per day the Rowhurst seam cost 2s. 8d. per ton for coals delivered into waggons at bank. Wages at 4s. 9d. per day, the cost per ton into waggons was 3s. 4d.

In working the Rowhurst by punch and thirl, the bottom part, near 6 feet thick, was first got, the parting between the coals dropped and stowed up on one side of the boards. The upper seam was dropped below the first stenting or thirling back from the face of the boards, and the pillars afterwards thinned. By stowing the thill or parting away in the boards, the pillars in the bottom coal were buried, and considerable expense was incurred to clear away the stowed material, in order to thin the pillars. The stowage and removal of the thill entailed an expense of 4d. to 5d. per ton on the coal. Several trials have been made to get this seem (Rowhurst), by long work on the Staffordshire plan, but without success. It was attempted to work the whole height of seam (12 to 13 feet high) at one operation, and to support the roof by posts or rather

trees; such supports could not break the roof along the face, and when a weight came the face of the work was lost. Had the nature and structure of the roof been studied, another arrangement of the work might have suggested itself.

The level course runs nearly magnetic north and south. The cleat of the coal 8° to 10° east of north. The roof, for 12 feet above the coal, is hard compact metal post, with cleavages running in the direction of level course.

My plan for working this seam by long work is shewn by *Sketches* 6, 7, 8, *and* 9; *Sketches* 6 *and* 7, plans of work; *Sketches* 8 *and* 9, sections. By forming the face of the work on the level course, the partings of the roof are bared, and it breaks down without pressing on the coal face. In this arrangement, the inclination of the seam tends to throw the pressure of the roof from the face. *Sketch No.* 6, shews the progress of three banks, each 40 yards wide; a goaf road for running the coals down, is formed up the middle of each 40 yards bank; 20 yards on each side being got and sent down the goaf road, which is a self-acting incline plane. This road is formed by building pillars with the fallen roof, 7 to 8 feet wide up each side, 4 feet high to a parting in the lower seam. The upper part of the lower seam over the goaf road, is cut and dropped to the edge of the plates at the top of incline, and the parting between the coal is also dropped, and used in the formation of the goaf road pillars. Until the roof falls, the goaf road pillars are formed with the strongest portion of the parting between the seams, assisted with a few chocks, which are removed after the first fall of roof. Referring to *Sketch No.* 8, it will be seen that in the goaf road roof there are 7 to 8 feet of coal and thill, in which head room can be cheaply made when the pressure of the roof contracts the size; before the whole is cut away to make head room the roof is settled down upon the floor, and the road then stands as well as one in solid coal. I work the bottom coal 10 feet in advance of the upper *(see Sketches Nos.* 8 *and* 9*)*, hole in the parting between the coals; upon the material, from the holing I set the chocks to support the roof, which reduces the height to chock to 5 feet. A lift, 4 feet wide, is got across the face of the lower seam, and the top seam is dropped behind the timber and loaded up with the lower seam. In some parts of the mine the lower seam is open in the cleat, and can be got with levers; in other parts shots are put in every 7 yards, 2 feet from the floor. As the lift is got off across the face, the back row of chocks are separately brought forward to 5 feet from the face of the lower seam. When the lift is taken across the face, the plates at the top of

the incline are removed forward 4 feet, and the face is again worked across as before. To adjust the incline chain to the constant lengthening of the incline, a piece at each end of the chain is double, and let out as required. When all the chain is paid off another piece is added, and connected with a rivet link. 40 tons of coals and slack are sent from a 40 yards bank daily. When the men become expert in the work, more will be sent out. By introducing this system, forming good roads, fitting up the shafts with guides for cages, the cost for putting coals on to the pit top is reduced 6d. per ton, and the quantity of slack is considerably less.

Sketch No. 10.—Transverse section of the long work in the Burnwood coal and ironstone. The plan of the work is the same as shewn in *Sketches Nos.* 6 *and* 7, with the exception of another set of chocks for working the ironstone.

Sketches Nos. 11 *and* 12, shew plan and section of the work for getting ironstone in the roof of a coal seam where the coal has been got. The strata in which the stone is deposited, and for several yards above, are argillaceous, and the action of the air and water for several years have made it more like an old pit heap. The coal has been got, board and pillar (punch and thirl). The pillars left are from 1 to 2 yards thick and from 5 to 8 yards apart. The levels and going roads have to be formed and maintained with timber, set every 5 or 6 feet, and the roof and sides covered with slabs. From the levels I drive narrow boards up the old coal pillars, and work by means of these boards the stone over an old coal board to the next pillar. When the stone is got to within 6 yards of the rise levels, the coal and stone are picked out of the going board, and as much of the timber as can be got out with safety.

NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS.

ANNUAL MEETING, THURSDAY, AUGUST 3RD, 1854, IN THE ROOMS OF THE INSTITUTE, WESTGATE STREET, NEWCASTLE-UPON-TYNE.

NICHOLAS WOOD, ESQ., IN THE CHAIR.

The minutes of the last meeting were read and confirmed. The financial statement, which was read by the Secretary, shewed the Institute to be in a very flourishing condition. Several new members were proposed and elected, and officers chosen for the ensuing year. The retiring officers were re-appointed with the exception of the Secretary, Mr. Sinclair, who is about to remove to a distant part of the country. The thanks of the Society were unanimously voted to the retiring Secretary for his efficient services; and Mr. Thomas Doubleday was elected to the vacant office.

The paper by Mr. G. C. Greenwell, "Notes on the Coal Field of East Somerset," was then read, and the discussions on papers were postponed until the next meeting.

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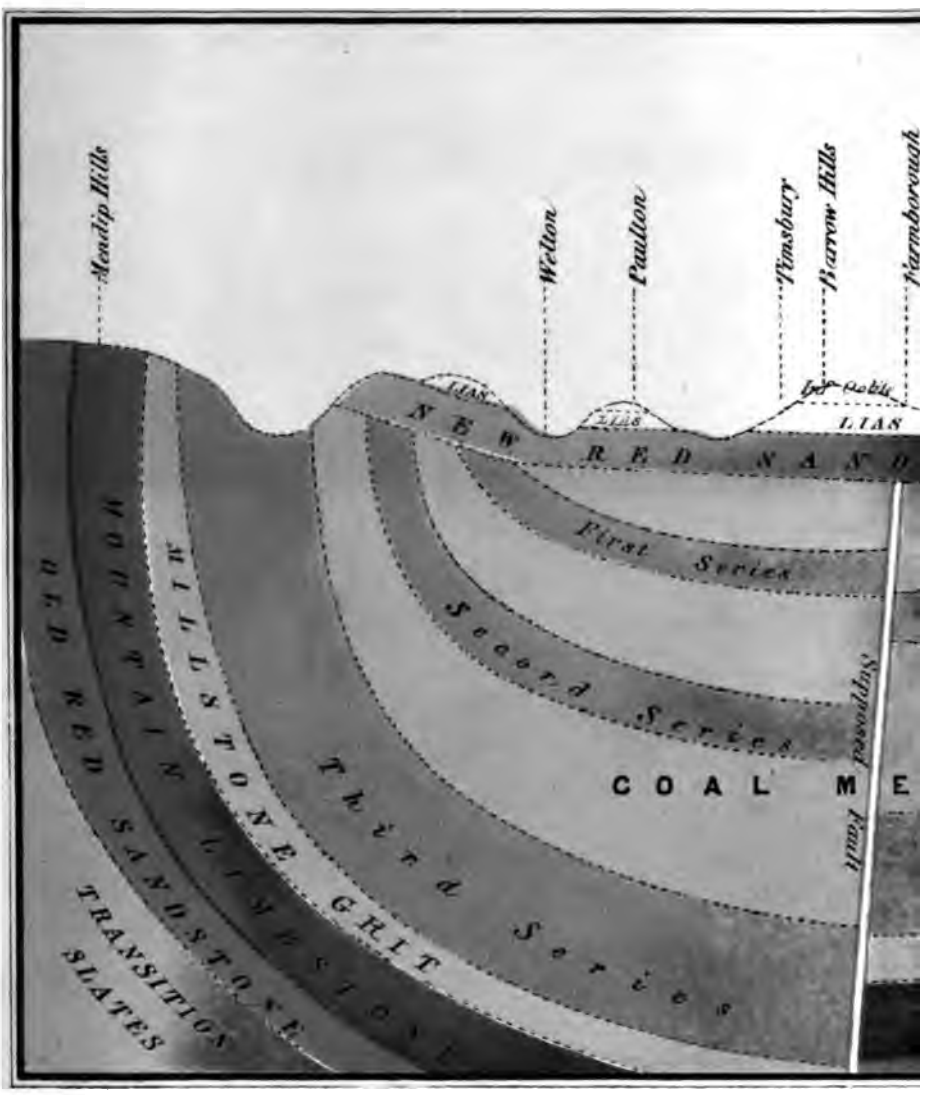
GEOLOGICAL MAP

Great & Inferior Oolite
Lias
New Red Sandstone

SECTION OF


Meadip Hills
Welton
Paulton
Timsbury
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Farmborough
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NEW RED SAND
First Series
Second Series
Third Series
COAL ME
Supposed Fault
MOUNTAIN LIMESTONE
HILLSTONE GRIT
OLD RED SANDSTONE
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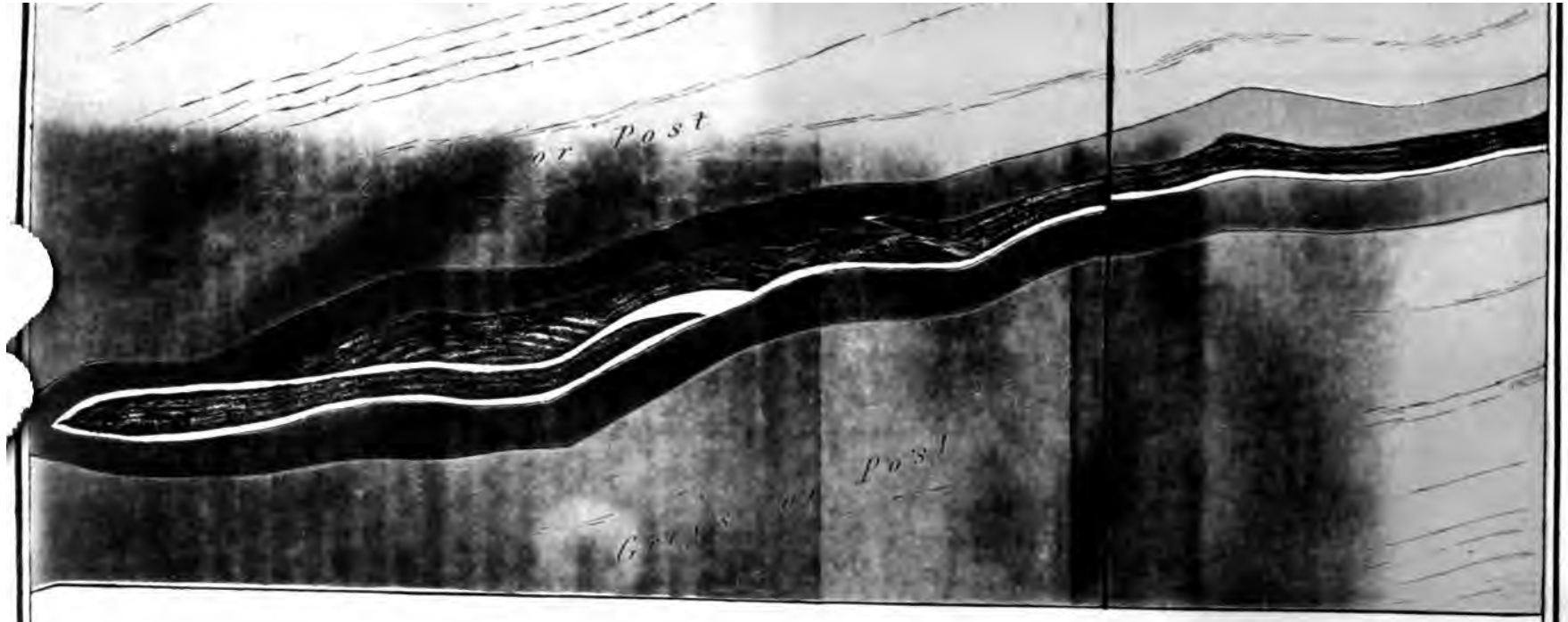

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NOTES

ON

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OF

MERSET.

REENWELL.

Any detailed account of this coal field, my short residence in the district necessarily precludes my entering upon at present; some of its features are, however, so prominent, and, as applicable to certain portions of the Northumberland and Durham coal field, so interesting, that I trust no apology will be necessary for presenting the paper which I have now the honour of submitting to the Institute. It is of the utmost importance to a society like the present, that its sources of information should be widely disseminated, and that, by its embracing the consequent facilities for centralization and comparison of facts, it should be prevented from falling into the too frequent error of arriving at conclusions founded upon insufficient data; and, I trust that other distant members of this influential body, who, by their position, are so well fitted to add to its store of knowledge, will, ere long, show that they agree with me in this opinion.

It will be seen by reference to the Geological Map *(Plate* 1*)*, accompanying these notes, that the coal measures of East Somerset may be shortly defined as resting, as in the North of England and elsewhere, upon millstone grit, which is again based upon the mountain limestone, &c; and, as these same substrata rise from beneath the coal measures in the Northern, Western, Southern, and in all likelihood (as seen near the

nd Chipping Sodbury) Eastern direction, the whole, most probably uncomformable in detailed structure, may be o possess a certain conformability in general position.

this expression, I would be understood to mean that there is not any abutting up of these inferior formations against an overlay of neasures, such as we shall observe when treating of the position of al measures, with regard to the rocks of which they in turn form bstrata.

probable thickness of the coal measures, at the deepest part of the eld in the neighbourhood of Radstock, may be 6,000 feet, in which e are three distinct series of seams of coal, as shewn in the general tion *(Plate 2)*.

The aggregate thickness of the various seams of coal (or veins, as they locally named), 33 in number, is 81 feet 4 inches, as shewn in the ailed section following :—

of ns	Thickness of Coal. Feet.	Inchs.	FIRST SERIES.	Faths	Feet.	Inchs.	Faths	Feet.	Inchs.
			Coal strata, shale, grit, &c., to Great vein	160	0	0			
1	2	4	Great vein	0	2	4	160	2	4
			Coal strata	7	0	11			
2	1	4	Top little vein	0	1	4	7	2	3
			Coal strata	9	2	2			
3	2	0	Middle vein	0	2	0	9	4	2
			Coal strata	16	0	0			
4	2	0	Slyving vein	0	2	0	16	2	0
			Coal strata	6	1	7			
5	1	2	Under little vein	0	1	2	6	2	9
			Coal strata	4	3	0			
6	2	4	Bull, or New vein	0	2	4	4	5	4
			Coal strata	9	3	0			
7	1	0	Nine-inch vein	0	1	0	9	4	0
			Depth to bottom of first series, proved at Radstock, &c.,	....	....	....	214	4	10
			SECOND SERIES.						
			Proved at Farrington, Timsbury, &c.						
			Coal strata	80	0	8			
8	2	0	Coal	0	2	0	80	2	8
			Coal strata	5	4	0			
9	1	10	Coal	0	1	10	5	5	10
			Carried forward	....	....	....	301	1	4

No of Seams	Thickness of Coal. Feet.	Inchs.	(SECOND SERIES CONTINUED.)	Faths	Feet.	Inchs.	Faths	Feet.	Inchs.
			Brought forward.....				301	1	4
			Coal strata	7	2	9			
10	3	3	Coal	0	3	3	8	0	0
			Coal strata	9	4	4			
11	1	8	Coal	0	1	8	10	0	0
			Coal strata	5	4	2			
12	1	10	Coal	0	1	10	6	0	0
			Coal strata	21	3	5			
13	2	7	Coal	0	2	7	22	0	0
			Depth to bottom of second series	....	....	....	347	1	4
			THIRD SERIES.						
			Proved at New Rock, Nettlebridge, &c.						
			Coal strata	80	0	0			
14	3	0	Globe vein	0	3	0	80	3	0
			Coal strata	65	0	0			
15	1	6	Small coal vein	0	1	6	65	1	6
			Coal strata	55	0	0			
16	2	0	Two coal vein	0	2	0	55	2	0
			Coal strata	10	0	0			
17	2	0	Wharkey course	0	2	0	10	2	0
			Coal strata	3	0	0			
18	3	0	Garden course	0	3	0	3	3	0
			Coal strata	30	0	0			
19	1	6	Strap coal.....	0	1	6	30	1	6
			Coal strata	35	0	0			
20	6	0	Great course.....	1	0	0	36	0	0
			Coal strata	40	0	0			
21	1	6	Fire-stone coal.....	0	1	6	40	1	6
			Coal strata	20	0	0			
22	1	6	Little vein	0	1	6	20	1	6
			Coal strata	43	0	0			
23	3	0	Dunny drift coal	0	3	0	43	3	0
			Coal strata	7	0	0			
24	3	0	Hard coal vein.....	0	3	0	7	3	0
			Coal strata	7	0	0			
25	1	6	Stone coal	0	1	6	7	1	6
			Coal strata	35	0	0			
26	4	0	Standing coal	0	4	0	35	4	0
			Carried forward.....	....	....	....	782	4	10

	Feet.	Inches.	(Third Series Continued.)	Faths	Feet.	Inches.	Faths	Feet.	Inches.
			Brought forward	....	....	....	782	4	10
			Coal strata	31	0	0			
27	2	6	Fern rag seam	0	2	6			
							31	2	6
			Coal strata	6	0	0			
28	2	6	Stone rag vein.....	0	2	6			
							6	2	6
			Coal strata	6	0	0			
	6	0	Callows vein	1	0	0			
							7	0	0
			Coal strata	10	0	0			
30	5	0	Perrink vein.....	0	5	0			
							10	5	0
			Coal strata	5	0	0			
31	2	0	White ash coal.....	0	2	0			
							5	2	0
			Coal strata	40	0	0			
32	3	0	Red ash coal	0	3	0			
							40	3	0
			Coal strata	20	0	0			
33	1	6	Willmott's vein	0	1	6			
							20	1	6
	81	4	Total explored	....	....	....	904	3	4

The proportion of coal contained in the entire thickness of coal measures amounts to only 1·5 per cent.

The coal of the first series is the best in quality; it is of a bituminous character forming a cheerful and very durable fire, but produces more ash than the better classes of coal found in the Northumberland and Durham coal field. The long wall method of working is universally adopted, the undermining or benching being performed in the under clay, by which means the coal is brought to the surface and sent to market in very large blocks.

The strata interposed between the seams of coal, consist of shales and grits of different kinds; the shales are similar in character to those of the Newcastle district, although perhaps abounding more in bright and glassy partings; they consist of sagre clay (called "pan,") capable of being formed into firebricks of fair quality, and blue metal ("clift") of various thickness, and containing organic remains in, I think, greater abundance and better defined than those found in the North of England.

The character of the siliceous rocks ("grays") is however different; they are much harder and frequently contain a curious intermixture of coal, the entry of which into the composition of these rocks is a somewhat difficult problem to solve: so far as I have yet been able to ascertain there is no white sandstone (or "white post") in the Somersetshire coal field.

A very remarkable stratum occurs in the first series; it consists of a concreted mass of coal pebbles, cemented firmly together by a mixture of grit and shale.

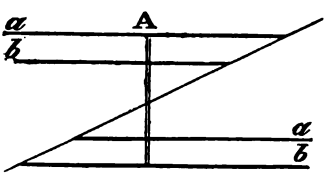
The coal field is traversed by several dislocations, some of which are of considerable magnitude; one of these passes in a North and South direction, through Radstock, in the position shewn on the section (*Plate* 3), and depresses the strata to the West about 100 fathoms. On the dip side of the dyke, the strata decline towards it at the angle of 20°.

The geological age of the faults of this district appears to vary; some of them (as at Timsbury,) affecting both the older formation of the coal measures, and those newer ones of the red sandstone and lias, by which it is covered, whereas others, of which the great fault at Radstock above-mentioned is a notable example, produce no effect whatever upon the formations overlying the coal measures, their continuity being unaltered in the slightest degree.

For some further observations on this subject see Messrs. Conybeare and Phillip's "Geology of England and Wales," part I, p. 257.

There are also some other faults of a singular description, termed overlap faults and rises, which constitute some of those peculiarities which it is the object of this paper to describe.

In the event of our finding any stratum cut off by a fault, it is the generally received opinion that when the line of hade forms with the thill of the stratum an acute angle, we may conclude that the stratum in question will be depressed on the other side of the fault, and *vice versâ*. The overlap faults above alluded to, however form a remarkable instance at variance with the above, the dislocation of the strata producing the effect shewn in the diagram, occasioning thereby a repetition of the seams of coal and other strata, so that a pit sunk at the point A, would pass through the same seams *a b* twice.



The principal fault of this description, is also shown in the section (*Plate* 3); by it the seams of coal are doubled for a breadth of about 150 yards, and the alteration in level occasioned amounts to 22 fathoms.

Several minor faults, similar to the above, occur in the district, some of them producing a difference of level of a few fathoms or feet, and others a mere forcing over of the seam of coal upon itself, as shown in *Plate* 4. In all these cases there is no deterioration of the coal in quality, and rarely any in its hardness, notwithstanding that the lines of stratification are sometimes contorted in a remarkable degree; these lines in one part

; parallel with the ordinary inclination of the seam of and in ot... parts (separated from the first by a mere parting), g at a very considerable angle to it.

. repetition of the coal of this kind is usually in the immediate vicinity an entire nip out of the coal, or what is termed "dead ground."

The nature of the roof and thill is in these cases little altered, with exception that the roof possesses more frequently than ordinary, sy and slightly coherent partings, rendering increased caution in ting beneath it, and care in propping, requisite in order to prevent it a dropping down.

any of the faults found in this coal field consist of sudden rises of e coal, not unfrequently at an angle of from 30 to 40 degrees; the ifference of level thereby occasioned, amounting in some instances to 8 10 yards. In these cases there is no alteration either in the thickness quality of the coal, and the roof and floor of the seams remain parallel as in other parts of the district.

The chief distinctive feature, however, between the East Somerset and Newcastle coal fields, as at present defined, consists in the super-position over the coal measures of the former district, of formations of a much more recent date than any of those beneath which coal has been worked in the North of England, and one of the principal objects of this paper will have been attained, if these notes should draw the more particular attention of the Institute to what is undoubtedly a matter of no slight importance. I allude to the existence, or otherwise, of the coal measures beneath the new red sandstone and liassic formations of the North-East of Yorkshire.

When treating of the presence of the coal measures beneath the upper formations in the Somersetshire district, the justly celebrated authors of the "Outlines of the Geology of England and Wales," observe, (Part I, page 254):—

"No inference can be drawn from this district in favour of similar trials elsewhere, since two peculiar circumstances here concur: first, the manner in which these more recent beds here overly the coal field, resting unconformably in horizontal planes upon the truncated ends of the highly inclined strata belonging to the coal measures; and secondly, the thinning out of many of the beds in this direction, in consequence of which the sands of the inferior oolites and the clay of the lias are greatly reduced, and have almost vanished in many places, leaving the freestone beds of the inferior oolite almost in contact with the lower stony beds of the lias; the new red sandstone also being greatly diminished in thick-

ness, so that a geological interval, equal in many instances to probably 2,000 feet, is here reduced to less than a quarter of that depth."

This passage, it need not be remarked, has reference, not to the absolute presence or absence of the coal measures beneath the oolitic, lias, or red sandstone formations, but to the thickness of these strata, which, under the circumstances of ordinary districts, would have to be passed through before the coal measures would be attained.

It is not my intention to enter into any speculations of this nature, but rather to leave them to form the subject of future investigation, and to confine myself to a mere description of the manner in which the "Overlay," as it is locally and most expressively termed, forms a component of the stratification of the coal region of East Somerset.

The number of formations of which the overlay at any point consists, depends, (1) upon the elevated or depressed situation of the surface where the section is taken; for, excepting under circumstances of dislocation by faults, they are found continuous and in a nearly horizontal position: and (2), upon the local thickness of each formation; the surface elevation only introducing a superior, when the thickness of the inferior formation is so diminished as to allow of such a result.

The variation in thickness of these upper formations, within short distances, is considerable, as will be seen by referring to the following sections:—

Formations.	Details.	Brays-down.			Radstock.			Paulton.		
		Fs.	Ft.	In	Fas.	Ft.	In.	Fas.	Ft.	In.
PART OF INFERIOR OOLITE..	Bastard freestone	3	0	0	9	0	0	3	0	0
LIAS	Grey marl	11	4	0	9	0	0	20	0	0
	Grey limestone	0	2	6				1	0	0
	Brown sandy do., ...	0	2	0						
	Brown limestone.....	0	2	6				0	1	6
	White limestone	2	0	0						
	Grey marl	0	4	0				2	0	0
	Dark shelly marl.....	1	2	0				1	0	0
	Do. with loose stones	2	2	0				1	3	0
NEW RED SANDSTONE....	Soft red marl and sand ..	17	3	3	26	1	8	22	0	0
	Hard red stone	0	0	4	0	1	4			
	Soft red sandstone	9	0	2	1	2	0			
RED CONGLOMERATE	Millstone	2	3	0	3	1	0	1	0	0
LOWER NEW RED SANDSTONE	Variegated shale with thin beds of red sandstone ..	7	1	3	10	3	6			

From this, it follows that an elevation which, at Radstock, would be surmounted by the lower oolite, would, at Paulton, only display more elevated beds of the lias formation.

APPENDIX

TO MR. T. Y. HALL'S PAPER ON THE

EXTENT AND PROBABLE DURATION

OF THE NORTHERN COAL FIELD,

WITH A DESCRIPTIVE PLAN OF THE BOUNDARY OF EACH OF THE FOUR COAL DISTRICTS, DIVIDING THE SAME INTO THREE EACH.

[The following pages ought to have followed page 235, but during the interval of preparing the Appendix other papers have been printed, and thus the order of folio has been broken.]

By a reference to the plan attached to the paper on the duration of the Northern Coal Field, which is of 750 square miles in extent, it will be seen that the coal field is divided into four sections as follows:—The first is the northernmost, and is called "The Steam Coal District," and is coloured on the plan—BROWN; the second is called "The Sundry Coal District," and is coloured—PINK; the third is what is termed "The Best Household Coal District," and is chequered or coloured—BLACK; and the fourth is called "The Coking and Gas Coal District," and is coloured—BLUE, thus describing the districts generally.

With respect to the first section, viz., the Steam Coal District, it will be found that it is bounded by the sea, with a portion under the sea; is apparently limited in its breadth from the sea to that of the outcrops of coal formation coming out at the surface of the earth, and is on the average not more than 4½ miles by 20, making thus, in the whole, about 100 square miles. The northernmost limit of the outcrops is at Amble Harbour near Warkworth, where it enters under the sea; and its eastern boundary may be traced from the outcrops of the coal formation south-west of Seaton Burn Colliery, thence from Seaton Burn pit to Burraton, and a little north of Holywell, Killingworth, and Earsdon collieries into the sea. The other and remaining boundary, except the sea-coal, may be described by the outburst of the coal formation, nearly running in a line with the York, Newcastle, and Berwick Railway, or from one mile west of Killingworth to Warkworth, by way of Blagdon Park, Stannington and Morpeth. In the latter part of Chapter XII. the Steam Coal Field is divided into three sections, and which are fully described. The pits in each are hereafter given.

The secon... district, coloured Pink, of sundry sorts, is also divided into three sections, one of which may be described north of the scribe of best coal lying north of the main dyke, from Seaton Burn colliery, and continues way of Prestwick and Throckley collieries, Montague Main—then by way Fawdon and Wideopen collieries, laid in; at which places the district estimated to be 28 square miles in extent, but the coal is considered of somewhat different description to either of the steam coal districts, or best coal lying next to the Main Dyke from Stella by way of Kilworth and Earsdon, (and which comprises 13 square miles, and it will found chequered or shaded Black, as good household coal, on the plan; this 13 square miles lays at a very great depth and great angle.) It y, however, be worthy of remark, that south of the Main Dyke and n Gosforth colliery to Culle... ...e is part of a district which shaded Pink, east of Newca... ...hat part, so far as bounding th on the Tyne, has had the... ...m, and that seam has been uch worked, and almost entirely ... off and abandoned, but which rmerly contained one of the very best workable seams of household s, viz., Wallsend, Percy Main, Willington, Heaton, Walker, and remoor. These collieries once contained the valuable Main Coal eam described in Chapter III., and Wallsend as worked by the late Wm. Russell, Esq., of Brancepeth Castle; but all having been worked off, at the best seam, this part of the coal field, like a portion under and on the south of the Tyne, from Hebburn by way of Harton, Jarrow, Manor Wallsend, and the sea at St. Hilda's, is shaded Pink on the Map to denote "sundry sorts of coal," still have part household coal good. *See* Chapter XXIV. Before leaving this district, I shall advert briefly to "the Swallow," or what is called the basin, as being the deepest point of the Northern Coal Field, in both the Northumberland and Durham counties; and I shall begin with the dotted line, a little south of the Steam Coal District, which is called the 90 fathom down-cast dyke, north at the Church Pit at Earsdon. This dyke, however, may be considered a down-cast north, of nearly double the dip at this point. The course of "the Swallow" from this point (Church Pit) runs north-west until it comes between the two Holywell Pits, and thence east of Seghill and Seaton Delaval, at which place it turns to the north-east, between the north and the east pits at Cowpen Colliery, and thence into the sea, a little south of the river Wansbeck. From this latter point and along the coast towards Amble, the coal seams all rise westward, the out-crop coming out west of Morpeth, Ulgham, and Warkworth. Again, it may be said that from a point at Earsdon Church Pit, and taking the south side of the Main Dyke, this Swallow continues through Percy Main, Jarrow Docks, west of Harton new Pit, and onward south until it comes into conjunction with the Coaly Whin Dyke, and probably the Heworth Dyke, all coming together about this point, at which place the Swallow seems to have been thrown further to the east, as is proved by the workings to the east of Monkwearmouth Colliery, and the depth of the Hutton seam, which is at a dip of 1800 feet. The Hutton Seam at Harton Pit will be 1,400 feet, but the Swallow being still further west and still deeper, we may, therefore, fairly take Monkwearmouth and also Sunderland Docks, thence a mile or so along the sea coast, opposite the proposed new pits, near the sea coast, as shown on the plan, a mile north of Ryhope, and next the dotted line by way of Seaham. Turn-

ing into the land near to Seaham Harbour, then westward, we have the coal rising south by Seaham and Seaton Pits, and also Murton Pits; next crossing the Hett Whinstone Dyke, a mile or more west of the sea coast, and a mile east of Easington. The dotted lines continue by way of Castle Eden, where the coal rises eastward as well as westward, and this dotted line is carried on to where it touches the red sand-stone north of south Wingate, and east of Trimdon Colliery, where the Five-quarter Coal Seam is cut out by the limestone coming down into it, both at Trimdon and Trimdon Grange Collieries, where the Butterknowle Dyke lies a little southward, and a little further south about the same place where the coal cuts out. At South Wingate pit, the main coal seam goes out, and the fire clay puts in with iron ore balls the size of hen eggs in it, few and far between. The low main seam, 36 feet lower, making 732 dip, with 70 fathoms limestone on above the stratification. Before this pit was dismantled or sold, it may have cost nearly £20,000 for pit alone which is a good pit shaft, and for railways and other machinery £70,000 more, making at that time and since say £100,000, and at 8 per cent. or 270 working days in the year, is equal to £30 per day for interest alone. This colliery has only one machine drawing 60 or 70 chaldrons of coals per day at this time. The like interest for more or less capital accordingly. South Wingate pit is to the extreme south of the Great Northern Coal-Field, Ratcliffe pit to the extreme north, Evenwood, near Cockfield Fell, to the west, Monkwearmouth to the extreme east, with North Biddick abandoned pit in the centre, where, instead of getting coal, the pit went down on cinders and troubles. The extent of this section of the coal field, part of which is called the household, amounts to 96 square miles, or little more than that with the 21 in the five-quarter seam, hereafter mentioned.

COLLIERIES IN THE STEAM COAL DISTRICT.

South of the Wansbeck.—Seaton Burn, Seghill, Seaton Delaval, Cramlington, Hartley, Cowpen, Blyth, Bebside, Bedlington, Netherton, and Barrington.

South of Widdrington.—Morpeth Banks, Longhirst, North Hartley, New Pit, (North Seaton Bore-hole to the yard coal,) Winning South Widdrington, and Widdrington Colliery.

North of Widdrington.—Ratcliffe, Togstone, Broomhill, and Acklington.

To return to what is termed the Second Section on the Plan, and termed "Sundry Sorts" of coal, is divided into three patches—the first part alluded to already consists of 28 square miles, and is bounded by the outcrop from the turnpike road between Seaton Burn and Stannington; also westward by the outcrop, at Heddon-on-the-Wall, then south of the Whinstone Dyke, at Coaly-hill, and finally by way of Fawdon and Wideopen, crossing the turnpike at Barraton. The second is a large patch, lying south of the Main Dyke, from Lemington to Whitley and Cullercoats, by the sea coast to Tynemouth, South Shields, thence to Whitburn, the river Wear to Biddick, and near Chester-le-Street, where it joins what is called the eastern part of the Coking District. It then continues by way of Lamesley (leaving Springwell, Heworth, and Felling Hutton seam gas coal to the east), Norwood, near Gateshead, thence westward

[illegible] ne [illegible] ad the Derwent to Blaydon Haughs, opposite Kitty's [illegible] Lemington. The third patch, Pink, is mostly to the north [illegible] f the Hett Dyke (or south of what is considered the best coal dis- [illegible] s seen on the plan). It is bounded by Hart, near Hartlepool, south [illegible] uth Wingate, thence on to Sedgefield, continuing a little way under [illegible] ut-burst of the formation of the red sandstone, until the upper coal [illegible], five-quarter and main coal, strike out towards Thickley and to Mid- [illegible] Grange, Brisleton, where the outcrop of formation of the furthest [illegible] imestone from the sea, above the coal formation occurred at this point [illegible] is near to the west part of the Cockfield Fell Whinstone Dyke.

[illegible] other line of boundary of this section may be said to continue on [illegible] ne Cockfield Fell Whinstone Dyke, near Evenwood, by way of the [illegible] wood Collieries, [illegible] owle Dyke—thence to West- [illegible] Pit, by way of [illegible] tt Dyke, taking the Wear by [illegible] f Croxdale near [illegible], [illegible] from Croxdale to Whitwell [illegible] ry, where it intersects the [illegible] ke. The aggregate of these [illegible] patches are fully described from [illegible] 11 to 17 in Chapter XXIV. [illegible] d amount together to about 307½ square miles.

COLLIERIES IN THE SUNDRY SORT DISTRICT.

North of the Main Dyke.—Fawdon, Wideopen, Coxlodge, Brunton, and Prestwick.

South of the Main Dyke.—Near Whitley, Shiremoor, Burdon Main, Percy Main, Willington, Wallsend, Bewicke, Craster, Walker, St. Lawrence, Heaton, Spital Tongues, Elswick, High Elswick, Fenham, Benwell, Mantague Main; all these collieries are on the north side of the Tyne from Gateshead to Tynemouth. The following are on the south side from Gateshead to South Shields, by the sea to Sunderland Moor, Pensher, the River Wear to Chester-le-Street, and thence, nearly by the turnpike road, to Gateshead, viz.:—St. Hilda's, Jarrow, Manor of Wallsend, Harton, Hebburn, Friar's Goose, Oakwellgate, Tyne Main, Felling, Heworth, Sheriff Hill, Stormont Main, Derwent, Crook, Eighton Moor, Springwell, Mount Moor, Usworth, Washington, Oxclose, North Biddick, Harraton, Fatfield, Chater's Haugh, and Monkwearmouth.

South of the Hett Dyke.—Lands, Storey Lodge, Evenwood, Tenant's at Thickley, Middridge Grange, Mason's Chilton, Bishop Middleham, Garmondsway Moor, Thistlington, Cornforth, South Wingate, Castle Eden, Attempt Pit (Mason's Chilton Pit); the coal seam worked there run out in a line with the wash from the Tyne south of Durham.

The Third Section, called "Household Coals," consists of three or four patches. I will take the first, which is a small patch called the Tees Wallsend, a district embracing about 11½ square miles. It will be found in the Map in the shape of an egg; and will be seen bounded by the river Gaunless and Butterknowle Dyke, at St. Andrew's Auckland, by Westerton Pit to the west of Ferryhill Railway Station, Little Chilton, Eldon, Coppycrooks, and Shildon near Blackboy. The second patch is called the Wear and Hartlepool District. It is east of Durham and Chester-le-Street, and thence by way of the river Wear, on to Pensher and to Sunderland Moor, north of the proposed pits at Ryhope, then on to the sea, next by the sea coast south to the Hett Dyke,

east of Easington, then westward from the good Hutton seam border, where the Dyke continues between Shotton and Haswell, also between Ludworth and Thornley by way of Whitwell, Cassop, and Hough Hall to the Old Elvet Colliery near Durham. The entire of this patch consists of 68 square miles or more. The third, which is only of 13 square miles in extent, called the Tyne District, and is north of the Main Dyke from Stella to Earsdon Church Pit, at several places, is a narrow strip of less than a mile in width, and which lies at a great depth, and dips rapidly at a great angle, consequently these good seams being difficult to work formerly have been left untouched, but since more mechanical means are used, at present they are working at Killingworth, Gosforth, Walbottle, and Townley Collieries. This dyke, although called the 90 fathom dyke, varies where it is put through at the western extremity, and at east and west Townley Collieries it is in some places less than 60 fathoms, but it increases, as it inclines eastward, as it is proved at Gosforth and Shiremoor, where it is put through and is found about double that depth. It still inclines deeper eastward, probably at 180 fathoms at the Church Pit at Earsdon, from thence it runs into the sea to Cullercoats, where, in consequence of its great depth, a piece of strata of limestone is put next the surface, which is the only piece of limestone on the north side of the Main Dyke. These three patches form altogether 92½ square miles, and will be found at Chapters XII and XXIV. The above patches are all chequered or shaded dark on the Map, except one portion which is given in Chapter XII., as under the sea, opposite Seaham and Ryhope, and extending two miles into the sea by nine in breadth, thus making 18 square miles. The coal here may probably be very valuable when obtained. On "Sundry Sorts," there is one of the four patches 21 miles alluded to, also chequered Black, and which will be found south of the Hett Dyke on the Five-quarter Seam pits, and which work a coal as good as the Hutton seam for quality and hardness. These 21 miles when added to other 8 miles, taken at other places, in patches that may be left, will make 47½ square miles; and these put to 92½ square miles, make altogether a total of 140 square miles, of what may be termed Household coals.

COLLIERIES IN THE HOUSEHOLD DISTRICT.

North of the Main Dyke.—Earsdon (Church Pit), Holywell (east), Holywell (west), Burraton, Backworth, Ditto A. Pit, Killingworth, Gosforth, Coxlodge, Kenton, Walbottle, Townley, and part of Stella Freehold.

North of the Hett Dyke and South of the Wear.—Haswell, South Hetton, Murton, Lyon's Hetton, Elmore, Downe's Eppleton, North Hetton, Hazard, Dunwell, Moorsley, Low Grange, Kepier Grange, Seaton, Seaham, Haswell, Houghton-le-Spring, Ryhope (new winning), Pensher, Whitefield, Newbottle, Plane Pit, Meadows, Rainton, Alexandrina, Resolution, Hunter's House, Pittington, Broomside, Old Elvet, Old Durham, Arbour House, Cocken, Fox-hole, George Pit, Whitehouse Brass-side, Sherburn, Sherburn House, Framwellgate Moor, Acorn Close, Sacriston, Nettlesworth, Waldridge, Edmondsley, Kepier, Belmont, Hough Hall, Shincliffe, Croxdale, Whitwell, Ludworth, and Littletown Pit where salt water was fonnd while sinking to main coal seam.

South of the Hett Dyke.—Shotton, Thornley, Castle Eden (Attempt Pit at Castle Eden), Wingate Grange, Trimdon, Trimdon Grange,

, West Hetton, Crow Trees, Hough Hall, Cassop Moor,

OY OR TEES WALLSEND.—Blackboy, Counden Leas-
terton, Adelaide, Deanery, Coppycrook, Eldon, Little
ill.

RTH AND LAST SECTION is called the Coking Coal District,
n is applied to coking, gas, and iron manufactories. It is de-
n Chapter XXIV, in three sections, viz.:—the Tyne, the Der-
the Wear, and consist jointly of 168½ square miles. The
ion consists of 84½ square miles, and is bounded by Durham
e river Wear to [illegible] en, the Butterknowle Dyke
of Westerton Pit, [illegible] kland, West Auckland, St.
's Auckland, Ether [illegible] Witton-le-Wear, the western
p of the coalfield t [illegible] y, thence between Cornsay,
teads, opposite Lanchester, by way of Ash to Witton Gilbert to
m, including Brandon and Brancepeth Parks in the centre. The
, the Derwent portion, is 62½ square miles, and may be called the
Hill, Tanfield, and Beamish Pontop Pyke District. It is bounded
by [illegible] ton Gilbert, near Durham, by the river Browney a mile south of Lanchester, to the out crop of the coal seams, thence a mile south of the Stanhope and Tyne Railway; also, northward by way of the out crop west of Conside Iron Works to the river Derwent, continuing down the Derwent between Gibside and Axwell Park to the river Tyne, north of Swalwell and Whickham, south of Benwell Colliery, then onward to Norwood near Gateshead, by way of Derwent Crook, Lamesley, Chester-le-street, Burnop Flat Colliery to Witton-le-Wear. The third, the Tyne portion, consists of 21½ square miles, and is divided by the rivers Derwent and the Tyne, and continues at Blaydon, Stella, Ryton, Newburn, Heddon Banks, Walbottle, Throckley, Wylam, Horsley Wood, Ovingham, Chopwell, Eltringham, and Mickley. This district, however, may be termed the Mickley, Wylam, Townley, Stella, Blaydon and the Chopwell Coking District, the Main Dyke going through the centre of it, making one-half to the north and the other to the south. The southern portion at Blaydon and Stella is where the peculiarly good gas coal seam is found in patches laying above the Townley seam.

In the above brief explanation, it will be perceived, that 714 square miles are accounted for, including 40 square miles under the sea, which when taken as the estimate connected with those districts, produces available coals for the market. It will, however, be seen by reference to Chapter XII, that the area is 705 square miles, but with the 40 or 50 miles under the sea, will make a total of 755 square miles; still out of this quantity in consequence of only one coal seam, and that thin, next to the western out crop of coal formation, there is not apparently more square miles available for useful purposes, taking into account the average prices for coals for the last 20 years than what I have previously estimated. It is, however, possible that some of the lower seams may continue further south to the upper limestone, and also, at the outcrop of red sandstone, as shown in the Map, from Sedgefield and South Wingate to Hartlepool. The boundaries thus described are nearly about

the same as described by previous writers on the subject; but I consider, more carefully measured, as regards the coal, of little account to the outcrop, and other places that may never be available.

In addition to the foregoing, the plan further exhibits the position of the Cleveland Iron Ore District, Alum Works, south of the river Tees and Redcar, at Roseberry Topping and other places. A little further south than what is included in the Map, there are other districts of iron ore, which are now taken up and worked extensively, and brought to the Tyne by Messrs. Charles Palmer and Co. in iron-screw steamers. The other coking coal districts on the Tyne, Wear, and Derwent, have large iron-ore districts, of a valuable nature, are west of Wolsingham, the Stanhope Vale; and further east are the Consett Iron Works. At Barnard Castle iron-ore is found, and, also, a little at South Wingate, where the coal seam cuts out into the clay. There is, also, another iron district, north of the Tyne, near to Bellingham and Redsdale, besides large new districts in Yorkshire, from Roseberry Topping towards Leeds, large districts are taken by Baring Brothers.

COLLIERIES IN THE COKING COAL DISTRICT.

Tyne.—Wylam, Horsley Fell (landsale), Prudhoe Main, Throckley, Mickley, Townley (west), Townley (east), Glebe, Stella Freehold, Hedley (landsale), Shibdon, Blaydon Main, Cowan's Pit, Carr's Dockendale, Garesfield, Chopwell, Crawcrook.

Derwent.—Norwood, Team, Armstrong's Landsale at or near an abandoned pit (Whickham), Marley Hill, Andrew's House, Crook Banks, Kibblesworth, Burnop-field, Crook Bank, Lintz Hall, East Tanfield, Urpeth, Ouston, Beamish, Stanley (east), Stanley (west), South Tanfield, Twizell, Craghead, Burnop Flat, Cresswell, Brooms, Greencroft, Crook Hall, Stokesley, Conside Pits, Pontop, Dipton, Shield Row, Harelaw, Tanfield Moor, Tanfield Lee, Medomsley, Old Medomsley, Acorn's Close.

Wear.—Brandon Old Colliery, Hedley Hope, Thornley, White Lee, North Roddey Moor, Roddey Moor Colliery, Jobb's Hill Colliery, Pease's West, Bowden Close, Brancepeth, Wellington, Whitworth, Byer's Green, Newfield, Hunwick, Old Park, Sunny Brow, North Bitchburn, Mary-hill Green, Buckburn, Whitefield, Woodifield, Elm-park, Witton Park, Old Witton, Old Etherley, Gatherthorne's, Lawton, Cow-close, Copley Bent, Butterknowle, Land's, Norwood, Little Gordon, Gordon, Norlees, West Auckland, St. Helen's Auckland, Woodhouse Close, Woodhouse, and Cockfield.

The Spital Tongues Colliery is a little way north of Newcastle, and has been worked by shafts sunk from the surface at the high main coal seam, which is a short way beneath the surface, and will be apparent from several surface falls observable in crossing the turnpike, and at other places on the Town Moor. This colliery, after struggling through for upwards of 20 years, has at length come into the hands of Edward Richardson, Esq., who is at present working it very prosperously. It may, however, be remarked, that its situation affords a natural cheap transit for shipping places on the Tyne, below the New Quay at Newcastle, by the aid of a tunnel under the Town Moor, used as a railway to convey the coals, by a fixed engine, from the pit to the shipping

es alluded to. At about 8 fathoms in this shaft the metal coal is ot 4 inches in thickness; the three-quarter seam next is 2 feet ches ditto. The low main seam, which has a band of stone varying m 3 inches to 3 feet, is 3 feet and upwards on places, making in all eet 6 inches. The Beaumont or Townley Seam is not sunk; but at North Elswick Pit adjoining it was about 3 feet 6 inches. The ockwell or lower seam is not yet sunk to. Adjoining the Spital ies Colliery are Fenham and the two Elswicks on the north side Tyne, opposite Norwood and the Teams on the south side of the , on the west it adjoins Benwell, Fawdon, and Wideopen Collieries, atterly these three colleries have been doing little or next to no-. Benwell Colliery is on the north side of the Tyne, and is situate t two miles above Newcastle Bridge. Before it stopped ing, it was wrought in the low se o the south side of the river, below east of the mouth of the nt; but as those seams were hey were soon abandoned. At well, a little further south, ear Whickham, the same thing occurred, where a pit was sunk by . Gibson and Co., in consequence of various troubles and dykes met , therefore the pit was abandoned. The Heworth Dyke may be near to this pit, as it appears split into several troubles, pointing in a direction to the Holborn Dyke, running from Stella to Ryton, and to Crawcrook; but between Swalwell and Whickham, in this same district there is an upper seam of coal now working by Joseph Armstrong and Co., for fire clay and coal. This part formerly supplied coals as early as any district to London, which were carted to craft on the River Tyne, so as to be shipped at Shields, for the use of the palace of the king. The cost of carting was 6d. per cart; for the crafts on the river 12d. per chaldron, and the freight being other 12d., made altogether 2s. 6d. per chaldron delivering at the king's palace in London. Similar difficulties as those alluded to, in laid in pits, appear to have existed at Blaydon-haugh, and to the west of Derwent, where numerous bore-holes were put down centuries ago; but even in this low district where the Heworth Dyke seems to come in the shape of a sandy formation, called a wash, there has been no temptation held out to sink many pits, both a mile above the Derwent and in the low grounds. At Shibdon a pit was worked about 50 years ago, and was lately re-opened by G. H. Ramsay, Esq., who has pumped the water out of the old workings, as well as at the workings westward of Blaydon and Stella. Before Shibdon Pit was drowned up the workings were progressing northward in the coal seams; but the gravel bed with large feeders of water, which, it was said, were cut into, caused the pit at length to be given up. While, however, the works were going on southward under the rising ground towards Winlaton, the coal seam was of good and fine quality, was free of water, and more regular towards the Chopwell estate, or coal mines belonging the crown, and at present worked by the Garesfield owners, with the Marquis of Bute, close to Chopwell, and instead of the Winlaton lordship, which they abandoned some years ago. The surface was found uneven and a little covered in, and the seams being so near together they often got emaciated by creeps, so that they were only partially worked. West of Shibdon is Blaydon, and also part of Stella freehold on the south side of the Main Dyke, both of which were formerly worked but were abandoned. They have, however, been

re-opened by Joseph Cowen, Esq., Blaydon, and the Stella Coal Company. High and Low Elswick, Benwell, Old Montague Main, near Bell's Close, are also on the south side of the Main Dyke, and of them it may be said, that in consequence of the price of coals having been much higher than formerly, all parties interested in them were moving again to resume working. On the north side of the Main Dyke, and also north of the Tyne, are Walbottle, Throckley, and Wylam Collieries, all at work; but Throckley, at present, is only a land-sale. Then further south-west, and on the south side of the Tyne, there are East and West Townley, Ryton Glebe, the latter nearly worked off; and adjoining these are Crawcrook, Prudhoe Main, and Mickley Collieries, but among this lot Prudhoe Main is abandoned. The district on the south side of the Tyne is divided by the Main Dyke, and on the north side of it is Townley Pit, the main coal seam of which is at a dip of 36 fathoms from the surface; but in the stratification before we come to this seam, we have seams of coal which may be the same as that which lies above the Main coal below Newcastle to Wallsend to Percy Main, &c. Chapter VII. fully describes the seams below these. There are five or six less in number of seams on the south than the north side in consequence of the Main Dyke throwing the seams up to the south side.

THE THICKNESS

OF THE

DIFFERENT WORKABLE SEAMS

AND THE

STRATA UNDER THE COAL FIELD,

NEAR THE TYNE, IN NORTHUMBERLAND.

In the coal field of Northumberland and the north shore of Coaly Tyne there are many pits now laid in and abandoned, the good household seams having been worked out, and the sections of the coal strata in and near the same district may be worthy of notice. Commencing at Whitley Colliery, both sides of Main Dyke near the sea at Tynemouth, from their last working seam (the Low Main, a depth of — feet), a boring was put down in 1818, as follows:—

					Ft.	In.
At 7½	Fathoms	.. Coal	0	0	0	11
37	Do.	.. Coal	0	10		
		Band	0	6		
		Coal	0	9½		
					2	1½
46	Do.	.. Coal	1	0½		
		Band	0	8½		
		Coal	0	5¾		
					2	2¾
50	Do.	.. Coal			2	2½

53 5 0¾ left off boring.

And at Burdon Main Colliery near the west end of North Shields, which is now working as a landsale. the High Main, a good Household Coal Seam, is:—

At 62	Fathoms	.. Coal	2	7½		
		Band	0	3½		
		Coal	3	0		
					5	11

			Ft.	In.
At 73 Fathoms The Metal Coal Seam			2	8
91 Do. The Yard Coal Seam as follows:—				
Coal.....	1	6		
Band	0	2		
Coal.....	0	11		
Grey metal	0	9		
Coal.....	0	5		
Grey metal	0	6		
Coal.....	2	10		
			7	1
At 98½ Do. The Bensham Seam as follows:—				
Coal.....	2	7		
Splint	0	2		
Coal.....	1	9		
			4	6
At 123 Do. The Low Main Coal Seam:—				
Coal.....	1	8		
Band	0	2½		
Coal.....	0	10		
Blue Stone	0	3		
Coal.....	2	6½		
			5	6

Leaving the coast at Whitley pits, we find a succession of abandoned, or doing little collieries, at Percy Main,* Wallsend, Heaton, Walker, St. Anthony's, St. Lawrence, High and Low Elswick, Benwell, Fenham, Wide Open, Fawdon, Callerton, and Montague Estate adjoining Throckley Old Colliery and Heddon Banks, boundering upon the Close House and Rift Estates. In the latter two the good coal seams have not been found but at Wylam Colliery and Horsleywood, the lowest workable seam, the Brockwell runs out to the day. The results of each must be so well known to most of the members of this Institute that it is not necessary to do more than give a few of the sections of the coal seams in each royalty, where they are situate. The above collieries, which have been abandoned, are, some of them, filling with water, which in time may rise to the pit's mouth, and also extend into the workings of adjacent pits.

Among the many sinkings and borings with which I have been kindly favoured by Thos. Emerson Forster, Esquire, I give one in particular —at Backworth—which is more in detail than any of the others, thinking that it is one of importance to the members of this Institute and the

* At or about Percy Main is the dip of the Northumberland coal field as from thence east towards the sea the strata begins to rise. Ryhope royalties, belonging to the Haswell Coal Company, form the dip of the Durham coal field, where the proposed pit to the Hutton seam will be 1,700 feet; consequently, if the lowest seam be in the "Brockwell," it ought to be at 2,000 feet; and, in that case, it would be 1,900 feet or so below the level of the sea. Near the other extremity of the coal field, west of Townley, at Chopwell colliery, the Brockwell seam is 260 feet below the surface, the surface being upwards of 400 feet above the level of the sea. At this point, in a pit at Chopwell, the Brockwell seam is upwards of 100 feet above the sea level, and where there is a bore-hole made below the Brockwell, nearly 300 feet, no workable seams are found. Although the four coal seams in this western part prove thin, yet they are workable and of fine quality; whereas, in the eastern district, all the facts ascertained go to prove the reverse and that very little good or workable coal is below the Hutton seam.

Coal Trade, as having been made so long ago that it is now only partially known. It is the deepest boring below the workable seams from the Low Main Coal and is near the deepest part of the coal basin near the Tyne and the sea coast in Northumberland.

	Ft.	In.	Thickness of Seams of Coal. Ft.	In.
At Backworth B pit which was sunk :—				
At 52fms., or 312ft., to the High Main Coal Seam			6	0
Grey Metal	0	2		
Foul Coal	1	9		
Grey Metal	0	5		
Ground Coal	2	5		
			4	9
At 92 fathoms or 552 feet, the Bensham Seam:—				
Coal	2	3		
Black Stone	0	6		
Coal	1	3		
			4	2
At 106 fathoms, or 636 feet, sunk to the Low Main Seam:—				
Cannel Coal (Jet)	0	2		
Splint	0	3		
Coal	2	1½		
			2	5½

	Fath.	Ft.	In.
Total sinking	107	2	5
Bored	99	1	0
	206	**3**	**5, or 1239 feet 5 inchs.**

The sinking to the Low Main Coal Seam as above:—

106 faths. or 636 feet Seam			0	0
153 „ or 918 feet Coal			0	7
160 „ or 960 feet Coal			0	5
164 „ or 984 feet Coal			0	9
166 „ or 996 feet Coal			0	11
176 „ or 1056 feet Coal			0	8
190 „ or 1160 feet Coal and stone				
Tender coal	0	8		
Good Coal	1	8		
			2	9
204 „ or 1224 feet Coal	0	0	1	3
206 3 5 or 1239-5 left off boring in blue stone.				

Section, Bigges' Main A. Pit, at :—

94½ fathoms, the High Main Coal Seam			6	0
100 " the Metal Coal Seam			2	6
104 " the Stone Coal Seam			0	6
114½ " the Yard Coal Seam				
Coal	1	2		
Band	0	7		
Coal	1	3		
			3	0
124 " the Bensham Seam			2	6

		Ft.	In.		
	arter Coal Seam ..	0	0		
	....	1	0		
	.....	0	6		
	.....	1	8		
				3	2
	Five-quarter Coal Seam ..			3	1
	he Low Main Coal Seam				
	Coal.....	2	0		
	Band	8	0		
	Coal.....	4	0		
				1	2
"	the Beaumont or Townley Coal Seam				
	Coal.....	2	5		
	Stone	2	4		
	Coal.....	0	4		
187½ "	Engine Main Seam				
	Coal.....	0	4		
	Stone	1	8		
	Coal.....	3	0		
				5	0

Left off at 193 fathoms, 10 inches, but the writer could not get the date of this deep boring.

Benton Pit, at 78 fathoms the High Main Coal Seam is the same as at Heaton, viz :—

Coal, (good)	6	6		
Thill.....	0	6		
Bottom Coal, (coarse)	1	2		
			8	2

Further to Low Main, 52 fathoms, and a section at 700 yards from Benton Pit shaft to the north is as follows :—

Top Coal, (good).....	0	10¼		
Band	0	3¾		
Good Coal	1	9¾		
Clay Band	0	6		
Good Coal	0	6¼		
Scarry Coal.....	0	7½		
Band	0	5		
Good Coal	0	4½		
Grey Thill Band	1	3½		
Coarse Coal.....	0	4½		
			7	1¼

This Low Main Seam is now working, and is improving as the explorings go northward.

At 53 fathoms the Yard Coal Seam is as follows :—

Coal	0	3		
Band.....	0	3		
Coal	2	0		
			2	6

There is no Five-Quarter Seam, and also, no Six-Quarter

[illegible] ie Low Main Coal Seam as follows:—

	Ft.	In.		
Splint	0	3		
Coal	5	1		
Slatey Coal or Badger	0	7		
			5	11

Cowpen Colliery (in the Bishop of Durham's Royalty), at 115 fathoms, the Low Main Seam north of the River Blyth, is as follows:—

Grey Coal	0	5		
Good Coal	4	6		
Foul Coal	0	5		
			5	4
Here the Yard Coal Seam is	3	4		
The Cowpen Maudlin Seam	4	3		
The High Main Coal Seam	5	0		
The Grey Seam, or Seams, as it is full of bands	5	6		
At Seghill Colliery the Grey Seam is with many bands of stone	7	0		
This Seam at Cramlington is with a number of bands	7	0		

At North Seaton, in the Parish of Woodhorn, at a borehole now going forward within one mile of Newbiggin, on the north side of the River Camboise:—

At 73 fathoms, the Yard Coal is	3	8		

This is only one fathom higher laid than the Yard Coal at Cowpen.

In Willington Colliery, Bigge's Main Pit, at 140 fathoms, the Bensham Seam is as follows:—

Jet (cast back in working)	0	1½		
Good Top Coal	2	1½		
Splint (cast back in working)	0	3		
Good Bottom Coal	2	2½		
			4	8½

This shews no very favourable section of the deeper strata except in the first or worked off High Main Coal Seam, other sections shew where the Low Main Coal Seam is good. Other seams that have been good in the same district are often so altered at short distances as to make a serious change, which is the case also in Durham as well as Northumberland. So far as we are able to see, or have penetrated, the Lower Coal Seams, that are good, are under, in most cases, parts of the Western Coal Field, do not appear so in the eastern field, near the sea, where they lay much deeper. The like may be said of the good Hutton Seam, where it lays deep over a large area of the eastern part of the Durham Coal Field, independent of the small portion south of the Hett Dyke; next to where the good Five-quarter Seam is found also only of small extent of area, thus lessening the workable area of the best coal seams.

At Killingworth Colliery:—

	Fathoms.		Feet	thick.
The High Main Coal Seam is	115 or 690 feet	and	7	0
The Metal Coal Seam is	122 or	and	3	0
The Yard Coal Seam is	128 or	and	3	10
The Bensham Coal Seam is	134 or	and	5	4

Below which search has been made to the extent of 180 feet, but to that depth no Low Main Seam was met with. The Metal Coal and the Yard Coal Seams are entire and unworked, and the Bensham Coal Seam is only slightly wrought.

At Burradon Pit, which lies about a mile to the north of Killingworth, the Low Main Seam puts in; its thickness there is about 3 ft. 6 in. and it increases in thickness towards the north and east. At Backworth the Low Main is only 2 ft. 4 in., and were a line drawn from Burradon to Backworth it would about shew where the Steam Coal is workable north of it. The Grey Seams are not in at Killingworth, and are thin in places at Burradon.

The Metal Coal Seam at Burradon is 3 feet thick, and the Yard Coal Seam is 2 feet 10 inches in thickness, neither of which have been wrought.

Particular districts have certain thicknesses of coal, and the lower coal seams do not extend over the whole area.

At Burradon Colliery, which was part leased of Killingworth Colliery Owners, the Low Main Coal seam is at 140 fathoms, or 840 feet:—

	Ft.	In.	Ft.	In.
Jet (which is cast back in working)	0	4		
Top Coal (good)	3	0		
Band	0	1		
Bottom Coal	1	8		
			5	1

Weetslet Royalty.—About 800 yards west of Burradon Pit, the Low Main Seam is—

Jet	0	3		
Top Coal (good)	3	5		
Parting	0	0		
Bottom Coal (good)	1	10		
			5	6

From where what is called the Monkton Seam, near the surface about Hebburn Colliery, at

112 fathoms, the High Main Coal	5	6		
120 " the Metal Coal	0	0		
133 " the Grey Seam or Seams, with stone bands	7	0		

Not in the strata at Burradon, or thin in places where found, and not in at Killingworth.

143 " the Yard Coal Seam	3	0		
156 " the Bensham Seam	0	0		
The Five-Quarter and the Six-Quarter	0	0		
The Low Main Coal	5	0		
			20	6

The Metal Coal, Grey Seam or Seams, Yard Coal, Bensham, the Five-Quarter, and the Six-Quarter are not in the strata at Burradon, or they are only thin in places where found; they are not in at Killingworth.

West Cramlington Colliery the depth to the High Main Coal Seam is 9 fathoms, and the seam is—

	Ft.	In.		
Coal	0	5		
Black Stone and Coal	1	10		
Grey Metal	3	3		
Coal	0	11		
Band	0	3		
Good Coal	2	11		
			9	7

[illegible] fathoms a seam is found as follows:—

Coal, strong and coarse	3	8		
Band	0	1		
Coal	2	0		
Splint Coal	0	4		
Coal	0	3		
			6	4

At 31 fathoms a seam is found as follows:—

Coal	0	6		
Band	0	3		
Coal	0	7		
			1	4

The limestone formation north of the Tyne, is on at Tynemouth Priory, and also at one place, north of the Main Dyke, at Cullercoats. On the south of the Tyne, it is at a quarry, between St. Hilda Pit and Westoe, at 20 fathoms; but, a short way westward, the limestone is not on the surface as at St. Hilda or Harton Collieries. At Monkwearmouth it is found at 34 fathoms in thickness, and will be more at the Ryhope new winnings, south of the Wear, between Monkwearmouth, Seaton, and Seaham new pits, as the limestone at these places is 58¼ fathoms. At Murton Pit, two miles further south, where the sand under the limestone was so difficult to sink through, it is still of greater thickness. Further south, and at Castle Eden, south of the Hett Dyke, it is 97 fathoms; and at Shotton and South Wingate it is somewhat less in dip; but, at Hartlepool Docks, a bore-hole was put down at 80 fathoms before it reached the Magnesian Limestone.

Depths of various Pits to Five-Quarter Seam on the Wear.—The Haswell Colliery Pits 90 fathoms, Shotton 125, Thornley 84½, Wingate Grange 74, Castle Eden 119, Coxhoe 34, South Wingate (to Main Coal) 116; the above are sunk through the magnesian limestone. Little Chilton 37, Newbottle 84, Pittington 40, Sherburn Hill 38, Pontop 31, Blackboy 25, Adelaide 37½.

The High Main Coal Seam North of the Tyne.—Percy Main, 133½ fathoms, Hebburn working to N. 131, Killingworth 115, Wallsend 111, Burradon 80, Tyne Main working to 33, Backworth, 32½, Seaton Delaval 32, St. Lawrence 34½, Hartley 24, Earsdon 12.

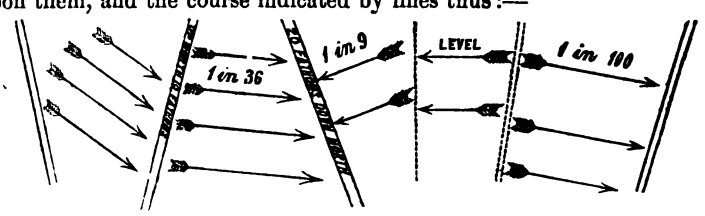
At Norwood pit, south of Tyne and near the Sea, a little above the level of the Tyne, the Beaumont Seam is at 42 fathoms deep. Then Marley Hill Colliery, on the high ground at Busty Bank Seam, is at 72 fathoms, Burnopfield high ground Main Coal is at 48 fathoms, and further on to Busty Bank at 42 fathoms, Pontop Collieryon the high ground to the Main Coal Seam, is 62 fathoms, and to Busty Bank it is 42 fathoms further.

PROPOSED MODEL FOR THE COAL DISTRICT.

In Chapter XIV. I briefly alluded to the propriety of adopting a Model of the whole District, as being more useful than the numerous sections required to show the entire Coal Field, on account of the number of different stratifications and coal seams and the various dykes being difficult to understand, especially by strangers; and I would here further suggest, that such a model could with great propriety be commenced by the society itself at little cost, much of the labour being already performed and in their possession. I am well aware it is only in its infancy as regards information, but from the amount of talent within it, and the practical experience of its members, I am very sanguine as to such a model being completed in first-rate style, and no doubt it would be invaluable to the coal-trade generally. Another point is, that a model of this description would in its results be some return to the liberality displayed by the coal owners, in not only furnishing our Society the present handsome and commodious suite of rooms to transact the business of the Institute, but in every other measure tending to promote its interests. After due consideration, I am of opinion, that there is no better plan for the construction of such a model than what I have proposed in Chapter XIV., which is by having plugs to represent the old shafts closed: hollow tin or glass tubes for the working pits, and the sections of the bore holes figured on plugs or scantlings of a flat shape thus: |‾|‾|‾|‾|‾|. Then as a means of improving it, the ordnance survey now in progress might be made use of to facilitate the work. I understand that the ordnance survey is six inches to a mile; and a model of the scale of 25 ÷ 10 feet would certainly be large, but to be useful it could not be made less. The levels of the pit top and bore-holes may easily be determined in consequence of the knowledge of the Mining Engineers representing the sections of the pit as well as the level of the top of it above the sea, or by a few sets from the "bench marks," which are always pretty closely placed over the entire face of the country, while the "contour lines" show exactly the nature of the undulations on the surface. This model also may be so constructed, as to allow any part of it to be lifted up, so that it could be seen from underneath, or in blocks of a mile square, so that each district or royalty of each coal-owner could be easily seen and examined entire, or in parts. The principal royalties are of great extent, and should the engineers of them procure the proper sections, the smaller colliery royalties, such as Belmont and others, I could easily obtain and dove-tail in from J. W. T. Bell's maps and other sources to make up the whole required for the model, with those that have large extent, viz., 20, 14, and 8 square miles each, which are those of the Earl of Durham's collieries, Lady Ann Vane, Dowager Marchioness of Londonderry, (a great portion of

latter held under the Dean and Chapter of Durham, working fast the best coal seams), also John Bowes and Co.'s collieries, Marley Hill 1 others, each of those say 20 square miles, equal 60 square miles. e Haswell Coal Company, including Shotton, and Ryhope, South Het-n, including Dalton and others, N. Wood, Esq. and Co., Black boy, Tees, allsend, Coundon, Westerton, Leasingthorne; and Harton, and Whitworth Co.'s royalties, each of these parties about 9 or 10 square miles, making 40; Thornley Coal Company, Thornley, Ludworth, and Trimdon, Jos. Pease, Esq., Brancepeth, and other places; Straker and Love, do., Jno. Robson and Jackson, Byer's Green, Hunwick, Coxhoe, Little Chilton, Stella Coal Company, Stella Freehold, Stella Grand Lease, Townley and Glebe, Edward Richardson, Charelaw and Langley, Cresswell, Eden, Derwent, Spital Tongues, and J. Joicey, Esq., Twizel, Beamish, Tanfield, each of these owners 8 to 10 square miles or more. The above, with four of the largest out of the 9 or 10 steam coal collieries, viz., Cramlington, Seghill, Seaton Delaval, and Barrington, each about 5 square miles, will represent one-third of the coal field that is leased for a long period of years to come, making about 200 square miles, and in the hands of only sixteen parties. The remainder of the collieries to make up what is alluded to and taken into account under the sea, with places unlet, may be seen in the sundry other names in the alphabetical list of collieries.

In addition to what I have already stated, I will give by way of making a beginning with the model, a few sections out of the many mining records at present in my possession, principally in the western district which lie at a great height above the level of the sea, as the surface of the eastern district near the sea is more uniform, and as many members are wellable to supply other records of levels, under-ground workings and dykes, the model thus once commenced might be made pretty accurate. The next point for consideration is the collecting throughout the districts, or sections of pits in royalties and bore-holes, and planning them on one uniform scale at one datum line, such for instance as the half-tide level of the sea, or the line half way between spring and neap tides, or the high water mark at ordinary spring tides which may suit best of all. After the sections are recorded, a tracing of the Main Faults in each district might follow, omitting the smaller ones, called hitches, of a certain magnitude, but such tracings to possess the rates of inclination of the strata figured upon them, and the course indicated by lines thus:—



When once these data where obtained and settled, then the remaining part of the model would be only mechanical and easily constructed, but the whole of it should be entrusted to the hands of a first-rate and skilful workman.

The following is a list of the levels above the datum line zero on Middlesborough tidal guage at different roads and railway stations, &c., but perhaps the better way for marking would be to take the Government sea mark level, which is so many feet below the mark fixed upon at the

Coal Trade Office, Neville's Hall, Collingwood Street. But as I possess the levels from Middlesbrough I subjoin a part of them as follows :—

	Ft.	In.
Middlesbro' Dock Platform	25	6
Say Hartlepool and Seaham, the like Stockton	34	1
Middlesbro' Branch Junction with Stockton and Darlington Railway	46	5
Redcar	25	6
Ormesby Beck and Road to Guisbro' to the Dock Branch at Middlesbro'	27	0
Yarm Station	98	8
Fighting Cocks, near Yarm Station	155	8
Darlington	170	6
Brusselton Engine	495	6
Etherley Engine	575	3
Hagger Leazes Branch Junction	358	1
Junction with Stockton and Darlington at Shildon	386	6
Bishop Auckland Turnpike	327	8
Wear Valley Junction	322	0
Wear and Darlington Junction	495	5
Crook Station	510	5
Auckland and Weardale Railway, near Crook	495	5
Top of Summerside Incline Plane	970	5
Turnpike to Wolsingham	1032	5
Stanhope and Tyne Railway Junction at Waskerby	1167	5
Meeting Slack's Engine	1315	5
Park Head Wheel House	1640	0
Wether Hill Engine	1445	5
Crowley Engine	1123	0
Bilton Stanhope Quarry	796	0
Junction with Auckland and Weardale	322	4
Witton Turnpike	329	7
Road from Wolsingham to Hamsterley	456	9
Terminus at Frosterly where the carboniferous limestone that lays under the coal seams comes to the surface	571	4

The above elevations are on the following Railways :—Stockton and Darlington, Bishop Auckland and Weardale, Wear and Derwent, Stanhope and Tyne, Wear Valley, Middlesborough and Redcar, and the High Level Bridge at Newcastle.

These levels as well as others, have been taken and proved by Mr. J. W. T. Bell, C.E. and General Surveyor of Estates and Mines, Newcastle; and for which I think the society ought to feel much indebted to that gentleman, as well as for several other valuable Plans he has published of the royalties in the counties of Durham and Northumberland. Another Plan to complete the series of six is just finished by Mr. Bell, but is not yet published, and which contains the Western Coal District of Durham and Northumberland.

The model might be made of gutta percha and other materials at first in blocks, then glass would perhaps be better in consequence of its transparency.

Since the author concluded his remarks about the coal fields of the world, information has been brought by Capt. Inglefield, who was sent out to the Arctic Regions in search of the missing expeditions of Sir John Franklin and Capts. Collinson and McLure, of the discovery of a valuable deposit of coal, of anthracite quality, on the island of Disco, in the latitude of 75 degrees. This discovery will enable whale fishers to boil down the blubber on the spot and bring the oil itself to their respective countries.

ALPHABETICAL LIST

OF

PITS IN DURHAM AND NORTHUMBERLAND,

KNOWN BY THE NAMES OF THE

TYNE, WEAR, DERWENT, TEES, HARTLEPOOL, SEAHAM, SUNDERLAND, HARTLEY, BLYTH, AND WARKWORTH.

By T. Y. HALL.

WORKING PITS.

1 Antrim Adelaide, Lady A.V.L.
2 Alexandrina, Lady Vane L.
3 Arbour House, Earl of D.
4 Adelaide Shildon, J. Pease
5 Acorn Close or Charlaw, E. R.
6 Auckland West, Bolckow & Vaughan
7 Andrew's House, J. Bowes and Co.
8 Allerdean, Eighton Moor, W. W. B.
9 Ashington, Harrison, Carr, and Co.

10 Broomside, Lady Vane L.
11 Brasside, Earl of Durham
12 Belmont, Bell and Co.
13 Black Boy, or Tees W. E., Nicholas Wood and Co.
14 Backworth, Waldie and Co.
15 Bedlington Pits, Davison
16 Broomhill, Burdon, and Co.
17 Buckburn
18 Butterknowle & Copley Bent
19 Bitchburn South, S. & L.
20 Bitchburn North, H. Stobart and Co.
21 Byer's Green, Robson and Jackson
22 Bitchburn New, Muschamp
23 Brancepeth, Straker & Low
24 Bowden Close, Jos. Pease
25 Burnopfield. Do.
26 Burnopflat, S. and Fletcher
27 Bebside New Pit
28 Blaydon Main, J. Cowen
29 Brandon, Jos. Pease
30 Blayden, G. H. Ramsay
31 Beamish, Joicey
32 Burraton, Carr and Co.
33 Burdon Main, Hope
34 Barrington Pits, Longridge
35 Bowburn, R. & J.
36 Black Prince Pit, Attwood

37 Cassop Moor, Philipson
38 Cassop, Philipson
39 Clarence Hetton, R. & J.
40 Crowtrees, Do., Do.
41 Cowpen, Carr & Co.

42 Cramlington Pits, L.P. & Co.
43 Cresswell, Anfield Pl., E. R.
44 Crook Hall, Consett I. Works
45 Castle Eden Pit, and Co.
46 Crookbank, J. Bowes & Co.
47 Craghead, Hedley
48 Coxhoe, R. & J.
49 Coxhoe West, Do.
50 Crawford and Co.'s, Fence Houses, A. B. Z. Pits, resumed
51 Conside
52 Conside Pits, Iron Co.
53 Chilton, Little, R. & J.
54 Castle Pit, J. Bowes and Co.
55 Coxlodge, see Fawdon Coundon, T.W.E., N.W. & Co.

56 Derwent, J. Bowes and Co.
57 Delight Pit, Do.
58 Dipton, Do.
59 Deanery, J. Pease
60 Dunwell, North Hetton

61 Eppleton Hetton Pits
62 Elemore Hetton Pits
63 Elswick Old Pit
64 Elswick Low Do.
65 Earsdon, Taylor's
66 Edmondsley, Tyzick
67 Etherley New, McC.
68 Etherley, Old, H. Stobart
69 Eldon, J. Pease
70 Eden, B. R.
71 Elm Park, J. Pease

72 Felling Pit, Carr and Co.
73 Friar's Goose
74 Framwellgate Moor, Green
75 Fenham Old Pit

76 Garesfield Co., Chopwell
77 Greencroft, J. Bowes and Co.
78 Gordon Old, & Little Do.
79 Gordon West Old Pit
80 Grange Low, Earl of Durhm.
81 Gosforth and Coxlodge
82 Grange, Kepier, and Hetton, Earl of Durham

83 Hartley, Carr and Co.
84 Heaton, Do.
85 Hebburn, Dalton and Co.
86 Heworth, Anderson and Co.
87 Harton, N. Wood and Co
88 Holywell West, J. L. & Co.
89 Holywell East, Do.
90 Harraton, Bell and Co.
91 Hough-hall, Do.
92 Heugh Hall, R. and J.
93 Homeside, Hedley
94 Hedley Hope, J. Pease
95 Hetton West, R. and J.
96 Hetton South Pits
97 Hetton North, Hazard Pit
98 Hunwick Pit, R. and J.
99 Houghton-le-Spring, Earl of Durham
100 Hetton, Lyon's Pits
101 Haswell Pits, Do. Co.

102 Jobshill, J. Pease

103 Kibblesworth, J. Bowes and Co.
104 Killingworth, Do.
105 Kelloe, So. Hetton, R. & J.
106 Kepier, Dixon

107 Ludworth, Thornley Co.
108 Leasingthorne, T. W. E., N. W. and Co.
109 Little Town, Earl of D.
110 Lumley, Bell & Co.
111 Lady Durham Pit, Earl D.
112 Lady Seaham Pit, Lady V.L.

113 Marley Hill Pits, J. B. & Co.
114 Mickley, by dayhole drift from surface, C. & Cuthbt.
115 Morpeth Banks Old Pit
116 Mount Moor, J. B. & Co.
117 Medomsley, E. Richardson
118 Marshall Green, Skinner
119 Murton, or Dalton-le-Dale, South Hetton
120 Moorsley, North Hetton
121 Monkwearmouth Pits

122 Meadows, Lady Vane, L.
123 Medomsley Old, J. R.

4 Netherton Pits. Birkinshaw
125 Nettlesworth, G. Elliott
126 Newbottle, Earl of Durham
127 Norwood Old Pit, J. Bowes and Co.

128 Old Durham, Lady Vane, L.
129 Oxclose, G. Elliott and Co.
130 Ouston, Hunt and Co.
131 Oakwellgate, Easton & Co.

132 Pelton Moor, G. & Co.
133 Pontop, J. Bowes and Co.
134 Pensher, Lady Vane, L.
135 Pittington, Lady Vane, L.
136 Peareth Old Pit, J. B. & Co.

137 Radcliffe Pit
138 Roddymoor West Pits, J. P.
139 Roddymoor East, Do.
140 Rainton Pits, Lady Vane
141 Resolution Pit, Do.

142 Seaton, Hetton, & Earl D.
143 Seaham, Lady Vane, L.
144 South Hetton Pits
145 Sherburn, Earl of Durham
146 Sherburn House, Earl of D.
147 Shotton Grange, Haswell Company
148 Shincliffe, Bell and Co.
149 Shadforth, Earl of Durham
150 South Moor, Bell and Co.
151 Seaton Burn, J. B. and Co.
152 Seaton D. Pits, J. L. & Co.
153 Seghill Pits, Carr and Co.
154 Spital Tongues, E. R.
155 Shield Row, Bell and Co.
156 Springwell, J. Bowes & Co.
157 Sacriston, W. H. Bell
158 Sunny Brow, S. and L.
159 St. Helens, J. Pease
160 Stanley East, D. Burn & Co.
161 Stanley West, Joicey

162 Trimdon Grange, Forster's, South Hetton
163 Trimdon, Thornley Co.
164 Thistleflat, J. Pease
165 Tanfield East, Joicey
166 Thornley, Towlaw, Attwood and Co.
167 Tyne Main, Losh and Co.
168 Towlaw L. S. Pits, Attwood
169 Twizell, Joicey
170 Tanfield Moor, J. B. & Co.
171 Tanfield Leigh, Joicey
172 Townley West, Stella Coal Co.
173 Tanfield South, J. B. & Co.
174 Thornley Coal Company's Pits
175 Townley Stella Coal Company Freehold
176 Townley's Glebe Pit, Do.
177 Town. East, Emma Pit, Do.

178 Usworth, G. Elliott & Co.
179 Urpeth, Hunt and Co.

180 Wingate S., Seymour & Co.
181 Washington, Mounsey & Co.
182 West Cramlington Pits, Waldie and Co.
183 Willington, Durhm., S. & L.
184 Wylam East, J. B. Blackett, M.P.
185 Waldridge, Sowerby & Co.
186 West Hetton, Robson and Jackson
187 Whitworth, Jobeson & Co.
188 Woode Field, Bolckow and Vaughan
189 Whitefield, Do.
190 Witton Park and Witton, Kirsip
191 Woodhouse Close, J. Pease
192 Whitwell, Ogden
193 Wingate Grange, Lord Howden
194 Whitelee, New Grahamsley, Bolckow and Vaughan
195 Westerton, T. W. E., Nich. Wood and Co.
196 Whitehouse, Bell and Co.
197 Walker, Lambert and Co.

PITS FOR LANDSALE PURPOSES.

1 Acklington
2 Armstrong's Pit, Whickham
3 Benwell Lister
4 Benwell Carr
5 Bewick's Mickley
6 Cocken Cars Dockendale
7 Callerton, Forster's
8 Cockfield Fell
9 Coundon, T. W. E., Nicholas Wood and Co.
10 Eltringham
11 Elvet, T. Crawford
12 Hedley, and Hedley Fell
13 Horsley Colliery
14 Howlesh, T. W. E., Nicholas Wood, and Co.
15 Ingoe
16 Kyo, Bucknock Stella Grand Lease
17 Longhirst
18 Lanchester
19 Mickley
20 Prestwick
21 Prudhoe, Johnson
22 Paddock Myers
23 Stormont, King Pit
24 Throckley
25 Townley B. Pit, R. Simpson
26 Widdrington
27 Winlaton

OLD PITS LAID IN AND NEW PITS SINKING.

1 Benwell Old Pit
2 Bishop Middleham Do.
3 Brusselton Bank Top New, Bolckow and Vaughan
4 Bell Close, Montague, Carr
5 Biddick, attempted Pits
6 Brunton Old Pit, J. B. & Co.
7 Blaydon Haugh trial bore holes, so far as the writer's experience has gone, trials here have been attended with no good results to projectors
8 Brooms
9 Coxlodge Old Pit
10 Crawcrook Fields Pit
11 Chilton, Little, Borehole, a workable lower seam at 130 fathoms, R. and J.
12 Coppy Crook Old Pit
13 Callerton, relaid Fawdon old railway, and after a short time abandoned it and also the colliery
14 Cornforth Old Pit
15 Chilton, near Rushyford Mason, where the coal runs into the sandy gravel
16 Castle Eden, attempted Pits
17 Chaterhaugh, drowned up by river overflowing its banks, 1771, lately re-opened and abandoned, but not until after working out of their limits
18 Crawcrook, worked out of its limits into Stella Grand Lease
19 Derwent Crook. J. B. & Co.
20 Fawdon with a railway, and formerly to below Tyne bridge, afterwards to Bell's Close above bridge, next with half chaldron waggons again below bridge, then laid in
21 Ferry Hill Old Pit, T. W. E., N. Wood and Co.
22 Garmondsway Old Pit, South Hetton

'ramlington New
. Pit, W. Hunter
Hetton-le-hole, attempted by
J. Lyons, but never got
the quick-sand
H Water Pits, Stella
Co., where the Tyne
overflowed and let the
water into Townley Stargate pit workings

Ivaston Old Pit, J. & R.
Jarrow

King's Meadows Old Pit now in the centre of the river Tyne, opposite Norwood south side, and Elswick estate on the north. This estate was in connection with the King's Meadows formerly, (now an island), and yet pays rates to Elswick Township.

Lintz New Pit, London Co.

Morpeth Old Pits
32 Mount Moor, J. B. and Co.
33 Manor Wallsend Old Pit
34 Mickley Hill Top. This pit was sunk in Wrightson's royalty, instead of Humble's as intended and expected

35 Norlees Old Pit

36 Percy Main Old Pit
37 Prudhoe Main, or Wylam South Pit, worked out of its limits into Stella G. L.

38 Ryhope, (intended pits), Haswell Company
39 Roman Road Old Pit (at the outcrop) near Blagdon, worked 1,000 years ago. King Ethelbert's Queen travelled over this pack horse road at 2 miles per hour. Queen Victoria travelled over the same place from London to Balmoral by rail, in Sept. 1854, at the rate of 60 miles per hour

40 Seaton North Borehole
41 Stella Coal Company, Hedgefield water pit
42 St. Lawrence Old Pit
43 St. Anthony's Old Pit
44 Sheriff Hill Old Pit
45 St. Hilda Old Pit, N. W. & Co
Shire Moor Old Pit
Shildon Lodge New Pit
Seaton Delaval; several pits sunk upon very thin steam coal seam, but it is now working in a bed 5½ feet in thickness. This colliery is ventilated by a powerful steam force from high pressure boilers under-ground, and has been so for many years past
49 Stargate Townley Stella Coal Company

50 Team Old Pit
51 Togeton
52 Thrislington Old Pit
53 Townley A. Pit, Stella Coal Company, Old Pit
54 Townley C. Pit, Stella Coal Company, Old Pit

55 Wylam A. Pit, the Tyne overflowed its banks in 1771, and filled it with water, afterwards pumped out and still working coal
56 Whitley Old Pit
57 Wide Open Old Pi
58 Walker, when in danger of being stopped, was assisted by lessors
59 Williamson's, Rev. —., Burnopflatt, resumed again by his assistance
60 Wallsend, out of its limits into Willington Pit, off work and may be perhaps resumed again hereafter. by lessor's assistance.